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THE SOURCE, CHEMISTRY

AND

USE OF FOOD PRODUCTS

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BY

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WITH 75 ILLUSTRATIONS

PHILADELPHIA

P. BLAKISTON'S SON & CO.

1012 WALNUT STREET

REPRINTED, AUGUST, 1915.
REPRINTED WITH ADDITIONS AND CORRECTIONS, MARCH, 1916.
REPRINTED, AUGUST, 1917.

THE MAPLE PRESS YORK PA

PREFACE

In recent years the facts concerning the source, composition and use of the different food products are becoming more generally known, and contributions to this subject are more widely appreciated than formerly. Although the writer fully realizes the immense field covered by the title "Food Products," nevertheless he has made the attempt to bring together in one volume of convenient size the more important facts in regard to that which we eat and drink. Many of these facts are distributed through a multitude of books, pamphlets and scientific reports, which are not readily accessible to the general public.

No attempt is made to give sufficient details in regard to farming to make a successful farmer, in regard to manufacturing food products to make an expert in this line, nor to give specific directions to the person who prepares the food for the table—all these topics are treated of in special books with which the market is already filled. The general principles of food production, manufacture and preparation are, however, treated in such a way that the reader may have a practical knowledge as to what constitutes a good food, and where it is obtained. It is only by knowing what good, wholesome food is, its composition and appearance, that we can hope for an improvement in the general food supply. When this knowledge is widely disseminated, public opinion will go far toward correcting any abuses that still exist in the food market; for pure food laws are but the crystallized sentiment of the united protest of the people against unwholesome and fraudulent products.

It is believed that this book will be found sufficiently complete to serve as a text for students of foods in our Colleges and High Schools, and to properly supplement and give more completeness to the ordinary courses in "Preparation of Food," "Selection and Economic Use of Food" and "Dietetics."

The plan followed in treating of the important foods and beverages found in the markets of the world, is to discuss their source, methods of preparation for the market, how they are packed, preserved and shipped, their composition and nutrient and dietetic value, and their use by people of different countries.

Special attention is called to the arrangement of the several topics, which while somewhat different, it is believed will be found more logical than that ordinarily adopted. After discussing the main points of importance under each heading, the by-products, and foods and beverages which are directly or indirectly made from this material, are considered. Thus, following cane sugar and glucose, confectionery is discussed; after grapes comes the consideration of grape juice, wine, and finally brandy—each in its appropriate place.

Illustrations are used where they will add clearness to the text, or where they will bring into prominence certain methods of production, manufacture or distribution of foods.

The standard books on food, nutrition, dietetics and food adulteration by such authors as Wiley, Leach, Tibbles, Snyder, Hutchinson, Thompson, Allen, Sadtler, Winton, Lusk, Wing, Gautier, Jordan, Sherman and others, have been freely consulted, and numerous footnotes refer to the most important sources of information utilized. The Reports of the U. S. Department of Agriculture and its various Bureaus have been found especially useful, and the author thankfully acknowledges the debt he owes to this important Department of the Government.

For many valuable suggestions and for assistance in reading copy and proof the author is under obligations to Prof. P. F. Trowbridge of Columbia, Mo., Mr. A. V. H. Mory and Mr. Donald M. Nelson of Chicago, Mr. Herbert S. Bailey of Washington, D. C., Miss Sarah M. Wilson of Philadelphia, Prof. W. C. Stevens, Dr. F. H. Billings and Dr. Edna D. Day of Lawrence, Kas., Mr. Rudolph Hirsch and Mr. Geo. W. Smith of Kansas City, Mo., Prof.

Isabel Bevier of Urbana, Ill., and Mr. C. S. McFarland of Burnside, La. Permission to copy illustrations has been duly acknowledged elsewhere, but special thanks are due to Mr. Jos. A. Arnold of the U. S. Department of Agriculture, the Central Scientific Co. of Chicago, and Mr. L. S. Bushnell of Kansas City, for courtesies extended.

E. H. S. BAILEY.

LAWRENCE, KAS.

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FOOD PRODUCTS

CHAPTER I

THE SOURCE AND COMPOSITION OF FOOD

To supply himself with food which shall build up the tissues of the body, and yield energy for daily work, has always been one of the most important problems which man has to solve. This outranks in importance even the question of clothing and shelter, for among primitive peoples especially much less time and labor are bestowed on these necessities than on how to get enough to eat. In the earlier times each family provided itself with food from the immediate vicinity of its dwelling; but as the conditions of society became more complicated, and great centers of population grew up, it was no longer possible to supply the people with food in this way, and it became necessary to depend on the labor of others to procure the food and bring it to our door. The business of supplying the world with food has gradually increased until to-day an immense number of laborers is employed in raising, manufacturing and distributing the food products of the world. This fact is illustrated, as far as the producers and manufacturers are concerned, by a study of the following table:

THE MOST IMPORTANT FOOD PRODUCERS AND MANUFACTURERS ARE AS FOLLOWS, FOR

1. **Cereal Foods.**
   - a. Farmers.
   - b. Millers of wheat, rye, corn, oats and barley.
   - c. Bakers of bread, crackers, cakes, pastry and pretzels.
   - d. Manufacturers of macaroni, vermicelli and food pastes.
   - e. Manufacturers of prepared "cereals," breakfast foods, proprietary and infant's foods.

f. Manufacturers of starches, yeast, baking powder, cream of tartar, baking soda, calcium phosphate, alum, aluminum sulfate and common salt.
g. Manufacturers of cereal by-products, as corn oil.

2. **Sugars.**
   a. Planters.
   b. Sugar manufacturers, from cane, beets, maple sap and sorghum.
   c. Glucose manufacturers, from corn, rice or wheat starch.
   d. Sirup manufacturers.
   e. Honey growers.
   f. Candy and confectionery manufacturers.

3. **Fruits and Vegetables.**
   a. Farmers, gardeners and horticulturalists.
   b. Canners, packers and dryers of fruits and vegetables.
   c. Manufacturers of jams, jellies, preserves, etc.
   d. Manufacturers of pickles, and of vinegar, mustard and similar condimental products.

4. **Fats and Oils from Nuts and Fruits.**
   a. Farmers and growers of nuts and oil-bearing fruits.
   b. Manufacturers of peanut butter, sweet oil, nut foods and vegetable oils.

5. **Nitrogenous Foods (Meats and Fish).**
   a. Farmers and stock raisers.
   b. Packers of beef, pork, mutton, fowls, and game for distribution and cold storage.
   c. Fishermen who obtain fish, clams, oysters, lobsters, crabs, sea weed and "sea food in general."
   d. Packers and dryers of fish.
   e. Canners of fish, lobsters, oysters, clams, shrimps, crabs, etc.
   f. Canners and packers of "prepared" or corned beef, of pork, mutton, sausages, devilled ham and similar products.
   g. Butterine and cottolene manufacturers.
   h. Hunters and game distributors.

6. **Dairy Products.**
   a. Farmers and dairymen.
   b. Butter and cheese manufacturers.
   c. Proprietors of ice cream and condensed milk factories.
   d. Proprietors of milk sugar factories, and other plants for the utilization of milk by-products.

7. **Egg Products.**
   a. Farmers and poulterers.
   b. Manufacturers of desiccated eggs, albumin and similar products.

8. **Spices.**
   a. Growers of spices.
   b. Millers and manufacturers of spices and condiments.
   c. Manufacturers of essential oils.

9. **Ice and Cold Storage.**
   a. Manufacturers and storers of natural and artificial ice.
   b. Proprietors of cold storage plants and refrigerator cars and vessels.
10. **Non-intoxicating Beverages.**
    a. Tea, coffee, cocoa and chocolate growers, roasters and grinders.
    b. Manufacturers of pop, soda water, lemonade and iced drinks.
    c. Manufacturers of carbon dioxide gas for carbonating beverages.
    d. Bottlers of natural and artificial mineral waters.
    e. Manufacturers of synthetic flavors.
11. **Intoxicating Beverages.**
    a. Manufacturers of malt, ale, beer, stout, porter, etc.
    b. Manufacturers of wine, cider and perry.
    c. Distillers and rectifiers of alcohol, rum, gin, brandy and whiskey.
    d. Manufacturers of cordials, liqueurs, etc.

Water.
   a. Proprietors of plants for the storage, filtration and distribution of water.
   b. Manufacturers and distributors of distilled and table waters.

Perishable and Non-perishable Foods

The food made available by this immense number of producers may be classified into perishable and non-perishable products. It fortunately happens that many of the staple products, like the cereals, keep for a series of years, and bear transportation to any part of the globe. There are, however, more food-stuffs that are of such a perishable nature that the greatest care must be exercised in keeping them long enough to transport them to a distant market. There are some, in fact, especially foreign and tropical fruits and vegetables, that are so perishable that they are seldom known outside the limited area in which they are grown. In general it may be said that the products of northern climates bear transportation better than tropical fruits and vegetables, although there are some exceptions to this rule. The animal products are of course all quite perishable, but under modern methods of transportation there is nothing to prevent their use in the countries on the opposite side of the globe from which they are produced. The importation of food-stuffs into the United States has nearly doubled within the last ten years. This increase is especially noticeable in the case of tea, coffee, cocoa, and tropical fruits. The importation of fruits and nuts is increasing at the rate of $3,000,000 a year, while the quantity of meats and animal products, such as cheese, that are brought into the United States, is four times as much as ten years ago.

Distribution of Food

In the early settlement of a country and among primitive peoples the food produced was distributed largely by the producers themselves, but as the population increased, several other methods of local distribution have been developed. First, in the large trade centers great municipal markets have been established, where the people can purchase daily the food needed. Market

FIG. 1.—City Market, Lausanne, Switzerland.

houses are erected, often by the city, and stalls are rented to the marketmen or farmers who bring in the produce. It frequently happens, however, that the farmers expose their produce for sale in the public market square, without any buildings, except such as they temporarily erect. (Fig. 1.) This method of supply is common throughout the Old World, and to some extent in the larger cities in the United States.

From some of the great food markets of the world, as the

Smithfield Covent Garden and Billingsgate in London, the Halles Centrales in Paris,[1] Washington and Fulton market in New York, and from the produce dealers in the vicinity, millions of people are *daily* supplied with food. (Fig. 2.) Without these daily activities the food supply of the people would immediately fail and famine be imminent. The slight blocking of transporta-

FIG. 2.—Market Place and Cathedral, Nuremberg, Ger. (Copyright, Keystone View Co.)

tion by some disaster, a storm, or a strike would immediately cause the price of food to rise, because the supply is cut off.

A second method of local distribution of food is by the licensed venders especially in the larger cities, who procure the food at the market or of wholesale dealers, and peddle it from house to house. This method, which is perhaps even more common in the older cities of Europe than in the United States, is extended into the

[1] Food and Flavor, Finck, p. 266.

surrounding country by the itinerant peddlars. One advantage of this method of distribution is that the housekeeper has the opportunity to inspect the food, and it is not necessary to spend so much time as in visiting the distant market square.

The third method of distribution and the one prevalent in the United States, is by the service of the local grocer. It is extremely expensive and is perhaps one factor in the present high cost of food to the consumer. It is not an economical method of distribution because the consumer pays for the large loss of perishable foods which the grocer must keep on hand to supply a varied class of customers; he must pay for one or more telephones that are used in taking orders, for the numerous delivery men and wagons that from each grocery supply families in different and often distant parts of the city, and unless the grocery be run on a cash basis, the paying consumer helps to bear the losses incurred from trusting those who never pay.

Sources of Food

All the food of man comes originally from the soil, the air and the water. There are however many transformations before the mineral salts, the oxygen, carbon dioxide, and the nitrogen of the air, and the hydrogen and oxygen of the water, are changed to the highly organized bodies which constitute our foods, but these changes are unceasingly worked out day by day in the laboratories of the plant and animal organisms. Plants are the great builders of foods; animals utilize and modify, yielding in their flesh a portion of the food they consume. Vegetable food is, however, a less highly organized and less concentrated form of nourishment than that from animal sources, and most animals that are used as food by man feed on vegetable foods.

The most primitive people of whom we have any knowledge not only used the wild animals caught in the chase, the fish and the wild fruits and berries for food, but they very early began to domesticate the animals and to cultivate the grains and fruits, so as to be less dependent on what they might chance to find provided by the hand of nature. There is no evidence that these early peoples were vegetarians, for the adaptability of the human body to the use of animal foods and the earliest history disprove this; indeed some of the most uncivilized peoples of the present day subsist almost exclusively on fish and game.

FOOD CONSTITUENTS

If we study the composition of foods, it is evident at the outset that the elementary substances of which they are composed are few in number, and that the highly complex food materials in the vegetable and animal kingdoms are built up from a few simple substances combined in innumerable ways. These elements or simple substances of the foods, which subsequently become a part of the animal body, are carbon, the central element of all organic nature, hydrogen, one of the constituents of water, oxygen which occurs free in the air and combined in water, and nitrogen, which is also free in the air and the characteristic element of animal tissues. These are the most abundant, but in addition to these and equally necessary in the development of plants and animals are sulfur, phosphorus, chlorin, fluorin, silicon, calcium, potassium, sodium, magnesium, iron, manganese, and copper—sixteen in all.

Just as it is possible for the architect to erect an infinite variety of buildings from a few simple building materials, so in the laboratory of nature these elements, properly fitted together, give us the substance of the roots, the seeds, the fruits of plants, and the complex animal products that are known as foods. The most convenient method of studying these "built-up" structures that we call the "proximate substances" is to first classify them according to their common properties.

Water is a constituent of all foods, for even those that are apparently dry contain from 7 to 20 per cent. of water. It is necessary to the growth of all vegetable and animal tissue. The occurrence and properties of water, and its relation to the foods in common use, are elsewhere discussed.

CLASSIFICATION

A common classification of foods is into *organic* and *inorganic*, although the per cent. of the latter is relatively very small. When food is burned all the organic material is converted into gases and disappears, while the inorganic or mineral substance remains behind and is known as "ash." As will be seen in a later discussion the mineral substances play a very important part in the processes of metabolism, and in building up the tissues of the body.

The organic substances of the food may be classified as follows, viz.: carbohydrates, fats, organic acids and nitrogenous compounds.

The **carbohydrates** are among the chief products of plant life. Some of them, like cane and grape sugar, are crystalline and soluble in water, while others, like starch and cellulose, are insoluble in water and have no crystalline structure. Most of these substances contain hydrogen and oxygen in the proportions to form water thus, H_2O. The more complex of these bodies are readily broken up by acids or ferments into some of the simpler bodies.

Fats consist of the glyceryl esters of the fatty acids or of the unsaturated fatty acids. They readily saponify with alkalies to form soaps. (See p. 307.)

The **nitrogenous** compounds or proteins are of a very complex structure, and are derived from both vegetable and animal sources. (See p. 19.)

I. Carbohydrates

1. *The cellulose or polysaccharid group* $(C_6H_{10}O_5)_n$.
   - a. Cellulose.
   - b. Starch, inulin, lichenin.
   - c. Glycogen.
   - d. Dextrin.
   - e. Malto-dextrin.
   - f. Gum (arabin, bassorin, cerasin).

2. *The cane sugar or disaccharid group* ($C_{12}H_{22}O_{11}$).
   a. Cane sugar (sucrose).
   b. Malt sugar (maltose).
   c. Milk sugar (lactose).
3. *The glucose or monosaccharid group* ($C_6H_{12}O_6$).
   a. Glucose (grape sugar or dextrose).
   b. Fructose (fruit sugar or levulose).
   c. Galactose.
   d. Mannose.
   e. Sorbinose.
4. *The pectose group.*
   a. Pectin.
   b. Pectosic acid.
   c. Pectic acid.

II. Fats

III. Organic Acids

IV. Nitrogenous Compounds (proteins)

a. Simple proteins.
b. Conjugated proteins.
c. Derived proteins.

Mineral Salts are also important inorganic constituents of foods.

CARBOHYDRATES

The carbohydrates are found in various vegetable substances, and are of exceedingly varied structure and composition. They are all composed essentially, however, of oxygen, hydrogen and carbon, but so combined as to make a very complicated molecule. In some cases we know how the different parts of the molecule are related, and in others, although we know the percentage composition, it is not possible with our present knowledge to determine the molecular weight, or, as we sometimes say, to know how many atoms go to make up the molecule.

The carbohydrates are among the best known and the most important foods, both for man and the lower animals. They are the most important nutrients in cereals, roots, stalks, fruits and seeds. Although the full mechanism of the building up of carbohydrates in plants is not understood, we know that through the energy of the sun's rays acting on the chlorophyl, carbon dioxide and water, which contain the bulk of the elements needed, unite to form these organic compounds. Some nitrogenous substances and the mineral constituents are drawn from the soil. The volume of oxygen liberated is equal to the volume of carbon dioxide which disappears.[1] The "net" results of the process may be represented thus:

$$6CO_2+6H_2O=C_6H_{12}O_6+6O_2$$

It is probable that formaldehyde is an intermediate product, and hydrogen peroxide is produced, as shown thus:

$$CO_2+3H_2O=CH_2O+2H_2O_2.$$

Under the influence of sunlight in the chlorophyl cell the hydrogen peroxide is rapidly decomposed into water and oxygen, and the formaldehyde built up into a carbohydrate. Glucose appears as a direct polymer of formaldehyde thus:

$$CH_2O \times 6 \text{ equals } C_6H_{12}O_6 \text{ (glucose)}.$$

POLYSACCHARIDS

Cellulose $(C_6H_{10}O_5)_n$, a carbohydrate of very complex character, is the predominating constituent of vegetable tissues. This, next to water, is the most abundant substance in the vegetable kingdom, forming as it does the basis of wood, cotton, linen and similar fibrous bodies. Absorbent cotton and "washed" filter

[1] Chemistry of Food and Nutrition, Sherman, p. 4.

paper are examples of almost pure cellulose. A peculiarity which distinguishes cellulose from most other vegetable substances is its insolubility in ordinary liquids, such as hot and cold water, alcohol, ether or dilute acids and alkalies. To be appreciably affected cellulose must be heated with acids or alkalies, an ammoniacal solution of cupric oxide, or other strong chemicals.

As cellulose is the substance from which the framework of the plant is built,[1] it gives rigidity to certain parts, and if these plants are used as food, the greater the proportion of cellulose contained the more difficult will be their digestion. There is more cellulose in the older parts of the plant, as the stem, than in the leaves and fruit; more cellulose in the leaves of the potato vine than in the tuber. In grains and seeds it is most abundant in the outer coatings, so that in the process of milling, the cellulose is concentrated in the bran and the starch in the flour.

The use of foods which contain considerable cellulose, but not so much as to render them indigestible, is illustrated in tender asparagus, or celery, young beets and radishes, which however become tough and inedible, as the proportion of cellulose increases with age. In reports of the analyses of foods, cellulose forms the major part of the portion called "crude fiber," but this term includes also small quantities of other substances of the same general character.

Digestibility

In the vegetable cells cellulose encloses the starch grains, and although it is to a certain extent permeable to the digestive fluids, it is very insoluble. When we study the action of the digestive fluids on vegetable foods it is important to take this fact into consideration. While the plant is young, some of the cellulose is in chemical combination with water, forming hydrated cellulose, a portion of which undergoes digestion, and produces heat and energy in the body.[2]

[1] Principles of Human Nutrition, Jordan, p. 76.
[2] Human Foods, Snyder, p. 8.

If food rich in cellulose is very finely ground it is more readily acted upon by the digestive fluids.

Some of the lower animals, as the rodents, can no doubt digest cellulose quite readily, but it apparently adds very little to the nutritive value of the food of man. Whatever digestion of cellulose does take place, in the intestines says Lohrisch,[1] seems to be due to the action of certain microörganisms by which fatty acids are produced, which upon absorption yield nutrients.

As will be seen in the later discussion of the various foods, whatever may be said of the lack of nutritive value of cellulose, it is of value mechanically, as it dilutes and gives more bulk to those foods which are rich in starch, sugar and protein. The eating of bulky vegetable foods, low in nutritive value, may however be carried too far, as their constituents are mainly digested in the intestines, where they are liable to ferment and produce gases which will cause the distention of the intestinal organs. In this way the use of an exclusively vegetarian diet may lead to unpleasant results.

Starch $(C_6H_{10}O_5)_n$ is the substance that is stored in the various parts of the plant, after it has been circulated through the plant in the soluble form of sugar. The food plants contain it, frequently to the extent of 60 or 70 per cent. It is stored especially in the seeds, but also in the roots, tubers, fruits, stems and leaves of the plants, where in many cases it plays an important part in giving a start to the young, germinating plant. The starch grains which are found in the interior of the cells are of a characteristic size, shape and appearance, a fact that aids greatly in the detection of adulteration, especially of cereals.

Starch with sugar may be called the "basic foods" of man, as they are the central and most important constituents of the vegetable foods which he utilizes. These foods also contain fats and nitrogenous constituents, which of course are essential constituents.

[1] Zeitsch. physiolog. Chemie, 47 (1907), through Sherman, Chem. of Food and Nutrition, p. 311.

Starch is furnished by different classes of foods as follows:

	Per cent.
By the **cereals**:	
Wheat flour	75
Rye flour	78
Oatmeal	68
Corn meal	71
Rice	79
Buckwheat flour	77
Barley	62
Millet	60
By **roots, stem and tubers**:	
Potato	18
Sweet potato	15
Sweet cassava	31
Arrowroot	23
By **leguminous plants**:	
Beans	57
Beans (green)	29
Peas (dried)	55
Peas (green)	17
Lentils	57
Peanuts	24
Soy beans	34
By some **fruits**:	
Bananas	22
Bread fruit	14
By edible **nuts**:	
Acorns	43
Chestnuts	42

PROPERTIES OF STARCH

Starch can be kept for a long time if perfectly dry and when stored in a dry place. The starch grains when suspended in cold water are not dissolved, and can readily be filtered from the liquid. In making starch paste it is necessary to heat starch in water to at least 70° C. The grains then swell to many times their original size, and if not separated from each other by an abundance of liquid, or some other substance such as fat or sugar, they stick together forming lumps. In a paste made below the boiling point the starch grains are unbroken, though much swollen, and on standing such a paste separates, the starch grains sinking to the bottom. At a boiling temperature the outer layer gradually dissolves and the starch makes a more homogeneous, but not more easily digested paste.

A starch paste is readily made by first mixing the dry starch with cold water, and then pouring the mixture into a large quantity of boiling water, and boiling for a few minutes. Thus prepared, the starch paste is semi-transparent, and free from lumps. It will mold or turn sour after a few days, unless preserved by some antiseptic, as borax or an essential oil.

When starch is cooked for some time it is so changed as to be more readily acted upon by the digestive juices. When heated with hydrochloric acid starch is hydrolyzed to mixtures of dextrin and maltose, and finally to glucose. Starch is also hydrolyzed by the ptyalin of the saliva producing dextrin and maltose, as in the previous case.

Test for Starch

To test for starch, boil the material to be tested for a few moments with water, cool, and add a drop or two of tincture of iodine, when a rich purple-blue color will be seen in case starch is present. Raw starch also gives the iodine reaction although more slowly, and different classes of raw starch react differently with iodine. The color fades from the iodine-starch solution when it is heated, but returns again on cooling.

Glycogen $(C_6H_{10}O_5)_n$ is sometimes called "animal starch," as it appears to have the same function in animals that starch does in plants. It is important as serving as a "storehouse" of reserve carbohydrates in fungi and those forms of plant life which cannot build up starch under the influence of chlorophyl.

Glycogen is a white powder, soluble in water, and may be extracted from muscles and liver. Oysters contain as much as 9 per cent. of glycogen. It is formed in the animal out of the sugars that are taken into circulation from the digestive tract, and acts as a reserve store of fuel for the maintenance of muscular energy.[1] As would be naturally expected, the storage of glycogen in the animal body is promoted by rest and by liberal feeding, and the glycogen is rapidly used up in muscular work.

Dextrin $(C_6H_{10}O_5)_n$ or $(C_6H_{10}O_5)_n.H_2O$, is not found ready formed in any quantity in food products, but is readily produced by the action upon starch of enzymes, acids or heat. It is sometimes called "British Gum," and may be made by heating starch, either alone or with the addition of a small quantity of dilute mineral acid.

Properties and Varieties

Dextrin as usually prepared, is a brownish substance, and differs from starch in being soluble in water. It may be precipitated from its solutions by alcohol. This carbohydrate is abundant in germinating cereals; it is formed on the outside of a loaf of bread during baking, and has a sweetish taste. Malto-dextrin, the variety of dextrin found in malted cereals, is produced from starch by the action of the enzyme, maltose. It is believed to be a compound in which one molecule of maltose and two molecules of dextrin are in some way linked together. The specific kind of malto-dextrin formed in any case is largely dependent on the temperature maintained during the process of malting. Dextrin is found on the market in three forms,[2] a powder, a granular amorphous product, and a milky liquid. It is used as a substitute for gum acacia and other gums, in photography, calico printing, making paper, making of felt, of printer's rolls and in the manufacture of ink. About 30,000 tons of dextrin are made annually in Germany. Both the imported and the domestic dextrin sells in large quantities at from 5 to 6 cents a pound.

Inulin $((C_6H_{10}O_5)_n + H_2O)$ is a starch-like substance found in solution in the sap of many plants. It occurs especially in the tubers of the dahlia and in the Jerusalem artichoke, and in

[1] The Principles of Human Nutrition, Jordan, p. 73.
[2] J. I. and Eng. Ch., Vol. 5, p. 77.

smaller quantities in the potato, chicory, dandelion and elecampane, and also in some lichens.

When obtained from any of the above sources by methods similar to those used for separating starch, inulin is a white powder, which does not yield a blue color with iodine. It is slightly soluble in cold and readily soluble in hot water, and by hydrolysis with sulfuric acid, it is changed into fructose. The latter sugar is used by diabetic patients, as apparently it can be assimilated. Diastase has little effect upon inulin, and the ptyalin of the saliva does not convert it into sugar, as is the case with starch. It is probably changed into levulose in the stomach by the action of the hydrochloric acid of the gastric juice, and thus becomes digestible. An inulin bread and biscuit have been put upon the market, but however wholesome for invalids they may be, their taste is not agreeable.

Lichenin ($(C_6H_{10}O_5)_n+H_2O$) is another peculiar starch found in Iceland moss and algæ. Like starch it swells up with hot water, and forms a jelly on cooling. This property makes it valuable for culinary and dietetic purposes. Digestive ferments do not affect it, but it yields dextrin when boiled with dilute acid, and a similar change no doubt takes place in the stomach when it is acted upon by the hydrochloric acid of the digestive fluids.

Gum, bassorin, cerasin, are amorphous carbohydrates, existing in many plants, which have the property of taking up water to form a thick viscid product. They are usually soluble in water and insoluble in alcohol, and may be converted into sugars by heating with dilute acids. The most important of these are *gum arabic,* cherry-tree gum or cerasin and bassorin, found in linseed and quince seed and many roots. Gum tragacanth is an important commercial product containing bassorin.

DISACCHARIDS

In this group are included cane sugar, malt sugar and milk sugar ($C_{12}H_{22}O_{11}$). When acted upon by weak acids or ferments they break up, by hydrolysis thus:

Cane sugar with water yields glucose and fructose. Malt sugar with water yields glucose. Milk sugar with water yields glucose and galactose.

Cane sugar (sucrose or saccharose) is by far the most important of these sugars. (See p. 95.) It is found in the juice and sap of certain plants, and is an important constituent of fruits. It yields barley sugar and later caramel on being heated. Sugar is soluble in 0.46 parts of water at 77° F., and in 0.2 parts of boiling water.[1]

Malt sugar (maltose) is formed in the process of malting cereals, and is an intermediate product when starch is hydrolized by boiling with dilute acids as in the manufacture of commercial *glucose*. Maltose is formed by the action of the ptyalin of the saliva or the amylopsin of the pancreatic juice on starch or dextrin, and the maltose-splitting enzymes of the intestinal juice hydrolyze maltose to glucose.

Milk sugar (lactose) is found in the proportion of from 4 to 7 per cent. in the milk of all mammals. In sour milk it has been converted by the lactic acid bacteria into lactic acid. Lactose reduces Fehling's solution,[2] but has only seven-tenths the strength of dextrose in this respect. Milk sugar forms hard rhombic crystals which are soluble in six times their weight of cold water and two and a half times their weight of boiling water.

MONOSACCHARIDS

In this group are included glucose, fructose, galactose, mannose, and sorbinose ($C_6H_{12}O_6$). These sugars are all soluble substances, unaffected by digestive enzymes, and if not attacked by bacteria in the digestive tract they are absorbed and enter the blood current unchanged.[3] They are readily susceptible to alcoholic fermentation and are utilized for the production of glycogen

[1] U. S. Pharmacopœia, p. 384.

[2] A solution of copper sulfate and Rochelle salts, made strongly alkaline with sodium hydroxid.

[3] The Chemistry of Food and Nutrition, Sherman, p. 6.

in the animal body and in the maintenance of the normal glucose content of the blood.

Glucose, grape sugar or **dextrose,** is abundant in fruit and plant juices, and in honey. It is manufactured commercially by the hydrolysis of starch. (See p. 118.) It has only two-fifths the sweetness of cane sugar.

Fructose, fruit sugar or **levulose,** occurs with glucose in plant and fruit juices and in honey. It serves, like glucose, for the production of glycogen in the liver, and the latter by hydrolysis yields glucose. It ferments with yeast and yields alcohol, but more slowly than dextrose. Fructose forms crystals of the rhombic system, but crystallizes with difficulty. The sugar in fruit, often called *invert sugar,* is usually a combination of glucose and fructose. and forms granular masses in dried fruits.

Galactose, although not found free in nature, is produced by the hydrolysis of milk sugar either by acids or enzymes, and appears to promote the formation of glycogen in the animal body. Galactose is also produced by the hydrolytic cleavage of certain gums and of Carrageen moss. (See p. 305.)

Mannose is produced by the oxidation of mannite which occurs in manna, in celery roots and other roots and barks, but does not occur ready formed in nature. It is also a product of the fermentation of sugar, under certain conditions.

Sorbinose is the sugar found in the juice of the fruit of the mountain ash and the service tree.

THE PECTOSE GROUP

The pectins are something like the gums in composition and properties, and are found in fruits, especially those that are partially ripe. On account of the presence of these substances in fruits the making of jelly is possible. (See p. 211.)

FATS AND OILS

These very important food substances are widely distributed in both plants and animals. The fat may be completely extracted from any of the finely ground vegetable or animal foods, by pressure or by digestion with ether, chloroform or similar solvents. The term "ether extract," which is often used in tables giving the composition of foods, refers to the material, mostly fat which is extracted in this way from the food. (See p. 307.)

THE ORGANIC ACIDS

The acids which exist in various parts of plants are sometimes present as salts of the metals, sometimes as acid salts, and occasionally are found free. The most important acids are malic, tartaric, racemic, and citric. They play an important part in the diet. They are found in most fruits and vegetables and their presence has much to do with the agreeable taste and odor. (See p. 310.)

NITROGEN COMPOUNDS[1]

Proteins

This substance called protein is of very complex composition, and contains the elements carbon, hydrogen, oxygen, nitrogen, and sulfur with sometimes phosphorus and iron. Different proteins from different sources are of such varied composition that there may seem little excuse for classifying them together, except for the fact that they all contain nitrogen. These bodies, which exist both in animals and plants, are built up through the vital energies of plants. They can be used by the animal body only after this preliminary construction in the plant cell. The average composition of protein, although it varies within rather wide limits, may be stated as follows.[2]

	Per cent.
Carbon	52
Hydrogen	7
Nitrogen	16
Oxygen	23
Sulfur	2

[1] Am. Jour. Phys., Vol. 21.
[2] Neumeister, Principles of Human Nutrition, Jordan, p. 46.

Familiar examples of the occurrence of protein are in lean beef, in the white of eggs, in blood and in the gluten of wheat.

The proteins may be classified as follows:

(a) **Simple proteins** including albumins, globulins, alcohol-soluble proteins, glutelins, albuminoids, histones and protamines.

One of the most important properties of the albumin is that they are soluble in pure cold water, and when this solution is heated to the boiling point, the liquid coagulates, and the albumins separate out as an insoluble substance. The ablumins can, therefore, be extracted from lean beef, from blood, from milk and from eggs by cold water. Plants contain a small amount of vegetable albumin which can also be extracted by soaking with water.

When plant or animal tissues are treated with water containing 10 per cent. of common salt, another considerable portion of the protein may be dissolved. This is called globulin, and is especially abundant in plants. Kidney beans contain 20 per cent., peas 10 per cent., lentils 13 per cent. and wheat 0.6 per cent. Special names have been given to the globulins from different seeds, as phaseolin to the one found in some species of beans, vignin to the one in the cow pea.

There are also animal globulins existing in the muscle and in the blood. The name **myosin** has been given to the globulin which is obtained from lean meat, **fibrinogen** to that found in blood. **Fibrin** as such does not occur in living blood, but is one of the products into which the fibrinogen breaks up when blood is exposed to the air. **Vitellin** is the principal protein found in egg yolk.

The **glutenins**[1] constitute the largest part of the nitrogen compounds of cereals. The tenacious substance which is left after washing the starch out of wheat flour (see p. 31) is a protein of this class. There are also alcohol-soluble proteins in cereals, such as **gliadin** from wheat and zein from corn. The gliadin and glutenins together constitute about 80 per cent. of the total nitrogenous material of wheat.

[1] Jordan, p. 52.

According to the recent classification mentioned, the term **albuminoids** should be restricted to the proteins found in cartilage, bones, feathers, hair, hoofs, horns and nails. The one which occurs in cartilage and bone is called **collagen**; that in horns, hoofs and similar tissues, a substance that contains considerable sulfur, is called *keratin*. Commercial **gelatin** is derived from the collagen which is extracted especially from the tendons. (See p. 359.)

(b) **Conjugated proteins,** including nucleoproteins, glycoproteins, phosphoproteins, hæmoglobins, and lecithoproteins.

The **nucleoproteins** are relatively abundant in such glandular tissues as the spleen, pancreas, and liver. One of the most important **phosphoproteins** is the casein of milk, which is insoluble in water but exists in suspension in milk. This coagulates, not by heat, but by coming in contact with a ferment as in the human stomach, or by the action of rennet in cheese-making.

A very peculiar compound, existing in the blood, is known as **hæmoglobin.** This, when decomposed, separates into a protein (globin) and a coloring matter (hæmatin), which when charged with oxygen is called **oxyhæmoglobin.**[1] This coloring matter or blood pigment has the property of very readily taking up and releasing oxygen, and plays an important part in the transfer of oxygen in the lungs from the air to the blood.

(c) **Derived proteins,** including proteans, metaproteins, coagulated proteins, proteoses, peptones, and peptides.

Lecithoproteins are derived from the yolk of eggs, the mucous membranes, the kidneys and other sources, and contain lecithin, a peculiar phosphorized fat.

From this brief description of the proteins it will be seen that, a knowledge of the different proteins, particularly as to solubility and effect of heat, acids and ferments, is plainly necessary to a proper understanding of foods and their uses.

Non-proteins

(d) **Extractives,** amides and amino acids.

[1] The Principles of Human Nutrition, Jordan, p. 61.

There are also existing in foods a few nitrogen compounds that are not proteins. Among these may be mentioned the **amides,** bodies found especially in plants, such as the asparagine of asparagus. These substances seem to be of importance in the transfer of the nitrogen compounds from one part of the plant to another, as from the stem to the seed,[1] and they are supposed to be of less value as muscle-formers than the proteins. The **extractives** that are obtained from beef, after the precipitation of the albumins by boiling, contain the compounds **creatin** ($C_4H_7N_3O_2$) and **creatinin** ($C_4H_7N_3O$) which seem to have little or no food value (p. 357).

MINERAL SALTS

The mineral salts, especially the compounds of the elements iron, calcium, magnesium, potassium, sodium, chlorine, sulfur and phosphorus, enter into the animal body and take part in the process of metabolism as essential constituents of the organic materials of the food. They are of importance in three ways: (1) "as the constituents which give rigidity and comparative permanence to the skeleton, (2) as essential elements of the protoplasm of the active tissues, (3) as salts, held in solution in the fluids of the body, giving these fluids their characteristic influence upon the elasticity and irritability of muscle and nerve, supplying the material for the acidity or alkalinity of the digestive juices and other secretions, and yet maintaining the neutrality or slight alkalescence of the internal fluids as well as their osmotic pressure and solvent power."[2] In the study of nutrition very careful attention has been given to the rôle which the various salts, as the chlorides, sulfur and phosphorus compounds, calcium and iron compounds play in the process of animal nutrition. These inorganic materials are abundant in both vegetable and animal food-stuffs, and their occurrence, and relative quantity as a part of the diet should be always considered.

[1] Loc. cit.
[2] Chemistry of Food and Nutrition, Sherman.

HEAT UNITS OF FOOD COMPOUNDS

Since reference is frequently made to the amount of energy available from different foods it is important briefly to define the use of this term as used in dietetics. The *unit* of energy adopted for a comparative study of foods is the "calorie." This is the energy in terms of heat which is sufficient to raise the temperature of 1 pound of water 4° F.[1] This energy or the number of heat units is determined by the use of an instrument called a calorimeter, in which a known weight of the food is actually burned, and the heat evolved is used to raise the temperature of a known weight of water. By very elaborate experiments it has been shown that there is a close relation between the results obtained by the calorimeter, and the actual energy produced in the body by the proper digestion and assimilation of the food.

As an illustration of the use of this energy unit, the energy value of a pound of edible material from a few food-stuffs is quoted from Jordan.[2]

	Calories
Sirloin steak	1210
Corned beef	1655
Fresh codfish	310
Eggs	720
Milk	325
Butter	3615
Oysters	260
Wheat flour	1645
Oatmeal	1845
Sugar	1820
Molasses	1360
Potatoes	375
Squash (canned)	250
Apples	320

The inspection of these values affords an opportunity for the comparison of different foods. The author in discussing energy points out that it is important also to distinguish between the

[1] Principles of Human Nutrition, Jordan, p. 161.
[2] Loc. Cit.

heat produced when substances are burned in the calorimeter, and the heat or energy that is available when used in the body, as it never happens that the combustible portion of a ration is entirely consumed in the body. This is the case because the food is never all digested, the digested proteins are never fully burned, and there is usually an escape of unconsumed gases from the alimentary canal, especially in the case of farm animals. As actual work is performed in the process of digestion, the term "net energy" has been introduced to apply to that amount of energy which is available, after that used up in the digestion and preparation of the food for use in the body has been subtracted.

CHAPTER II

THE COMPOSITION OF CEREALS AND THE MANUFACTURE OF STARCH

The term cereals includes the plants of the grass family (Gramineæ) which are used as food. Wheat, rye, oats, barley, rice, corn (maize) and millet belong in this class, and buckwheat and quinoa, although not grasses, are here considered. The grain consists of the germ, and the endosperm with its coverings, which are the parts mostly utilized for human food.

WHEAT (Triticum vulgare)

Considered from the viewpoint of general use, there is no cereal of so much importance as wheat, for not only does it grow readily in the temperate climate where the active peoples of the world are found, but its products are peculiarly adapted for the food of man.

The origin of wheat is lost in antiquity. Wheat was cultivated by the ancient Egyptians and Chinese, was grown in Mesopotamia and has been found in the pre-historic lake-dwellings of Switzerland and Italy. The present form of wheat may be as naturally found, or it may be derived from a wild plant some varieties of which, improved by cultivation, are still found. It was introduced into Great Britain by the Romans.

Varieties

The botanist recognizes three species which he calls the grain wheat, Polish wheat, and common wheat, and of each of these, there are numerous varieties. Although the quality is much modified by the soil and climate yet we commonly speak of wheat as—

1. Soft, starchy or winter wheat, which is sown in the fall and harvested in June or July, and,

2. Hard, glutinous or spring wheat, which is sown in March or April, and harvested in late July or August. The climate, of course, determines which of these can be cultivated to best advantage, in each particular locality, but in general the winter wheat is grown in the more temperate climates, and the spring wheat in the north where the summer is shorter. On the Continent the upland steppes of Russia furnish the greatest quantity of wheat, although large quantities are grown in India, Siberia, South America, and Central Europe. In the United States of America[1] the prairies of the middle west and northwest, which are in many respects similar to the steppes of Russia, are best adapted to the growing of wheat. This is especially true of Minnesota, Wisconsin, Nebraska, the Dakotas, Illinois, Ohio, Missouri, Kansas, Indiana and New York. It is interesting to note that this cereal is grown successfully in Canada, as far north as Manitoba, and Assiniboine. In some countries as Bohemia, parts of Russia, France and Germany, Scotland and Ireland, on account of the cost of wheat, it is partly replaced as food by rye, barley or oats.

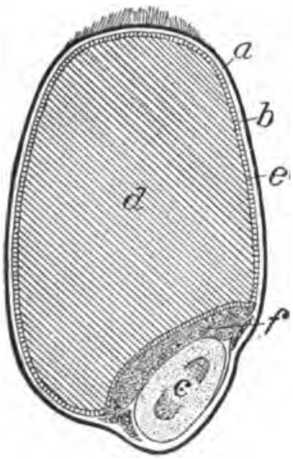

FIG. 3.—Structure of the wheat grain. By permission U. S. Dept. Agric. *a*, Wall of the ovary; *b*, testa; *c* and *f* embryo; *d*, starchy endosperm; *e*, aleurone layer.

Structure of the Wheat Kernel

The wheat kernel, or berry, when seen through the microscope has the structure as shown in Fig. 3. If the kernel, after

[1] References to the "United States" in the following pages are understood to mean "United States of America."

making a longitudinal section, be examined with a microscope of low power, the germ may be seen opposite the rounded end, with the starch and aleurone surrounded by the bran cells, constituting the bulk of the grain. The germ constitutes about 6 per cent. of the weight of the kernel. Its cells, as well as those of the endosperm, are rich in enzymes which, under the right conditions, transform the insoluble starch and protein of the endosperm into sugars, dextrins and amides, which the embryo plant is able to absorb during germination. If the grain is stored dry and is protected from moisture it does not deteriorate, but loses slightly in weight from drying. It is, however, liable to become infested with certain insects, particularly the granary weevil and the rice weevil, but these can be destroyed by the use of carbon disulfide in the bins where the grain is stored.

Spelt

Spelt (Triticum spelta) is the name applied to a cereal which is closely allied to both wheat and barley. It has been suggested that possibly wheat arose from spelt, or that they both had a common origin in a wild stock which no longer exists. The grain is closely contained in the husk like barley or oats so that the husk cannot be readily removed, by agitation or winnowing, and hence the flour made from this grain is coarse and of a darker color than wheat flour. Spelt is similar in composition to wheat except that it contains more cellulose and less protein than the latter. It was at one time the chief cereal of ancient Egypt. Spelts are grown on soils too poor to raise wheat, as in parts of southern Germany, Switzerland, Dalmatia, Servia, and northern Spain.

THE MILLING OF WHEAT

1. By the Use of Stones

The old method of "braying the grain" between two stones may have given rise to the word "bread" or a "brayed" product.

The hand mills of the Israelites, and those found in the ruins of Pompeii, belong to this type. (Fig. 4.) Later the mortar and pestle was almost universally used, and this was followed by stones run by wind or water power. The old fashioned burr-stone mills consist of a fixed nether millstone, upon which the upper stone revolves. The grain drops into an opening in the center of the upper stone, and gradually works outward between

FIG. 4.—Mill stones and oven, Pompeii.

the surfaces of the two stones which have a grinding surface cut in radiating lines. The meal is "bolted" or sifted to remove the bran. One advantage of this process over the modern roller milling is that the entire grain is ground, so that the finished product contains some of the bran, cerealin layer, and germ, which bolting does not remove. This flour, however, does not keep so well, is darker in color and more liable to become lumpy. In making genuine Graham flour this is the process generally used.

2. The Roller Process

It is only within the last forty years that the "roller" process for making flour, which came originally from Hungary, has been introduced into America. By this process about 75 per cent. of the grain is put on the market as a merchantable product. "The wheat is first screened and cleaned, then passed on to corrugated rolls or the 'first break,' where it is partially flattened and slightly crushed, and a small amount of flour, known as the 'break flour,' is separated by means of sieves, while the main portion is conveyed through elevators to the second break, where the kernels are more completely flattened and the granular flour particles are partially separated from the bran. The material then passes over several pairs of rolls or breaks, each succeeding pair being set a little nearer together. This is called the gradual reduction process, because the wheat is not made into flour in one operation. More complete removal of the bran and other impurities from the middlings is effected by means of sieves, aspirators and other devices, and the purified middlings are then passed on to smooth rolls, where the granulation is completed. The flour finally passes through silk bolting cloths, containing upward of 12,000 meshes per square inch. The dust and fine débris particles are removed at various points in the process. The granulation of the middlings is done after the impurities are removed, the object being first to separate as perfectly as possible the middlings from the branny portions of the kernel. If the wheat were first ground into a fine meal, it would be impossible to secure complete separation of the flour from the offal portions of the kernel."[1]

Grades of Flour

"What is known as patent flour is derived from the reduction of the middlings, while the break flours are recovered before the 'offals' are completely removed: hence they are not of so high

[1] Human Foods, Snyder, p. 138, and see also Milling Test of Wheats, Kans. St. Ag. Col. Ex. Sta. Bull. 177.

grade." According to the Standards of the U. S. Dept. of Agriculture, flour should not contain more than 13.5 per cent. of moisture, not less than 1.25 per cent. of nitrogen, not more than 1 per cent. of ash, and not more than 0.50 per cent. of fiber.

The grades of flour usually on the American market are First Patent, or highest grade, in which the gluten has a greater power of expansion than any other grade; Second Patent; "Straight" or standard patent, which includes First and Second Patent and first clear grade, and is the ordinary bread flour of the market; first clear; second clear, which although containing more gluten than higher grades does not contain the gliadin and glutenin in the right proportions to make good bread; and "Red Dog." the lowest grade. Other products which are used mostly for stock foods are shorts, or middlings and bran. In English milling practice the roller-milling products are sold under the following grades.[1] Straight Run, which consists of about 70 per cent. of the entire weight of the grain used; Patent Grade, and Baker's Grade.

Flour on standing sometimes absorbs water, and usually bleaches, on account of the action of enzymes or natural ferments present.

Varieties of Flour

Graham flour, which was first recommended by Dr. Sylvester Graham, an American vegetarian, in his book written in 1839, is the unbolted flour made by simply grinding the cleaned wheat. When properly made it contains a relatively larger proportion of the intermediate products—such as coarse and fine middlings of good grade—than does much of the so-called Graham flour on the market, which is made by mixing inferior grades of flour with feed-bran.[2] The term "*entire wheat*" flour or "whole wheat" flour as used in the trade is a misnomer, as it refers to a product

[1] Foods, Their Origin, Manufacture and Composition, Tibbles.
[2] U. S. Dept. Agric. Bur. Chem. Bull. 164.

which contains the germ and a portion of the bran, but not the entire grain.

Gluten flour, which is considered especially valuable as food for diabetic patients, ought to contain less starch and more gluten than the ordinary flour. According to the U. S. standard it contains 5.7[1] per cent. of nitrogen. The name unfortunately has been misapplied to various special brands, which are little if any richer in gluten than ordinary flours.

The *Durum* wheats, which somewhat resemble barley, while especially adapted to the making of macaroni, are not as valuable for general milling purposes as the ordinary varieties. The kernels are hard and almost glassy, and the beards are exceptionally long.

COMPOSITION OF WHEAT

The composition of wheat is as follows:

	Mean of 227 samples of wheat analyzed at the World's Fair[2]	Mean given by König. 420 samples[2]
Moisture	10.85	13.37
Proteins	12.20	12.51
Ether extract	1.74	1.70
Crude fiber	2.35	2.56
Ash	1.81	1.79
Carbohydrates	71.09	68.01

Wheat as a food product is valuable not so much on account of the large quantity of protein contained, as from its peculiar composition, and the fact that the protein can be separated in a coherent form from the other constituents by washing with water. It is the only cereal, with the exception of rye, which contains gliadin, a protein which forms the sticky dough, and entraps the gas bubbles during the process of rising. The protein[3] of wheat

[1] U. S. S. and Reg. Announcements, No. 58.
[2] U. S. Dept. Agric., The Analysis of Cereals, Div. Chem., Bull. 45.
[3] Osborne and Voorhees, A. Ch. Jour. Vol. 15, p. 392.

consists of a globulin, belonging to the class of vegetable vitellins, and which is present to the amount of 0.6 to 0.7 per cent.: an albumen, which forms from 0.3 to 0.4 per cent. of the wheat; a proteose; a gliadin, soluble in dilute alcohol and forming about 4.25 per cent. of the seed, and glutenin about 4 to 4.5 per cent. The gliadin and glutenin together form the gluten. These latter form about 85 per cent. of the protein of wheat. Gliadin in the best flours is present in about the proportion of 65 per cent. of gliadin to 35 per cent. of glutenin, and these, by the presence of mineral salts, are prevented from being wholly soluble. By this medium then, the particles of flour, which consist largely of starch, are bound together to make a tenacious dough.

Blending Different Wheats

Wheats from different countries as well as different kinds from the same country have different qualities. The English market is supplied with wheat from England, Scotland, France, Hungary, Australia, America, Russia and India. As these differ in quality and value, much skill on the part of the miller is required to so blend the different grains as to produce a satisfactory grade of flour. The American miller mixes wheats from different sections, and hard and soft wheats, to produce the required grades. In the large mills the various grades of flour are tested in the laboratory.

Bleaching of Flour

Some flours, especially those of the higher grades, are white while the lower grades are darker. As the white flour commands a higher price, it is to the advantage of the miller to get as much of the wheat into white flour as possible. This is done by various processes of bleaching, by the use of ozone, chlorine, or peroxide of nitrogen (NO_2). A common method of applying nitrogen peroxide gas to flour is to pass an electric charge through the atmosphere, thus causing a partial combination of its oxygen and nitrogen, and in a special apparatus to bring the fine flour in close contact with the nitrogen peroxide. Pending a final decision by the U. S. Courts as to whether the bleaching of flour shall be allowed, many States require that all bleached flour shall be so labeled. The process of bleaching flour is for the purpose of making "the product appear better than it really is," and it is a serious question whether this process should be allowed with so important a food product.

RYE (Secale cereale)

This grain, which came originally from the region east of the Austrian Alps, is extensively used for bread making in many European countries, especially France, Germany, and Russia. It is not of very ancient origin, and was not cultivated in the Roman Empire earlier than the Christian era. In the United States it is used to some extent by the farmers who grow the grain, and also finds great favor among the immigrants who have become accustomed to the use of rye bread in the old country. The chief use, however, is for the manufacture of whiskey and for stock feed. It grows well in the temperate zone, especially in the northern portion of the United States and in Canada. Although usually sown in the fall, in some localities spring rye is planted.

Composition of Rye

The general structure of the grain is similar to that of wheat. It contains 71 per cent. of starch and sugar, but the proteins of rye are of different composition from those of wheat.[1]

According to Osborne,[2] this protein contains among other substances 4 per cent. of gliadin; 0.43 per cent. of leucosin; and 1.76 per cent. of edestin and proteose. Although the gliadin in *Rye Bread* is similar to that of wheat there is present no protein corresponding to the glutenin of wheat. From this peculiar com-

[1] U. S. Dept. Agri. Bur. Chem. Bull. 13, p. 1337.
Carlton, U. S. Dept. Agri. Bur. Pl. Ind. Bull No. 3, p. 40.
[2] Jour. Am. Chem. Soc., 17, p. 429.

position the gluten is more sticky than that of wheat, and the resulting bread is darker and less porous. In parts of Germany a black bread made from rye and known as "pumpernickel," is a common food for the working people. This is a "sour-dough" bread, in which the fermentation is started with dough from a previous batch. The *Schwartzbrod*, quite common in certain sections, is made from a coarser flour than that used for "pumpernickel." This is not an economical food, as far as the protein digestibility is concerned, for in coarse rye bread as much as 42 per cent. of the total protein is lost during digestion, as compared with only 20 per cent. in the case of white bread.[1] The soluble proteins, which are more abundant in rye than in wheat, act upon the insoluble proteins and render rye bread moist, fine grained, and of small volume in comparison with the spongy, wheaten loaf. These same qualities, however, make rye flour an excellent medium for the growth of yeast cells, therefore a small quantity of rye flour is often used with the wheat in the preparation of the "sponge" used to raise the dough. In making rye bread, rye flour is commonly mixed with barley or wheat flour or corn meal. When wheat is used the best proportion is two parts of wheat to one of rye. In France a mixture of wheat and rye are combined for bread making under the name of **méteil,** and in Spain and Greece a mixture of barley and rye, has the same name. It should be noted that bread made from mixtures of different flours, since it is cheap and nutritious, might well take the place of straight wheat bread in cases where economy of food is to be considered.

The malted and fermented rye is a common source of alcoholic liquors, especially whiskey and in Russia "*vodka*." (See Alcohol, p. 143.)

ERGOT

There is a peculiar fungus called "ergot," which sometimes grows upon rye giving it the name "spurred rye. Ergot possesses certain poisonous properties, which, although valuable in medicine,

[1] Food and Dietetics, Hutchinson, p. 220.

render the product dangerous for use either by man or the lower animals. (See also U. S. Serv. and Reg. Ann. No. 25.)

OATS (Avena-sativa L.)

This very valuable cereal, which is always cultivated, and has never been discovered growing wild, is used as food both by man and beast. It seems to have been the original grain plant of Europe, where it has been known for 2000 years, and was used in Great Britain more than 600 years ago. It grows readily wherever the climate is cool and moist in the growing season. It is more susceptible to drought than wheat and some other grains. In the United States, it can be readily grown in the south by sowing in the fall, and in the north by sowing in the spring. In Scotland oatmeal has long been a favorite food material, and in the United States it has become, within the last forty years, one of the most important of breakfast foods.

Milling Oats

By the ordinary process of threshing and winnowing, the outer husk is not removed, and so oats, unlike other grains, comes to the market with this chaff still attached. The percentage of the kernel proper to the hull is as 73 to 27. Even in the process of milling, although the grain is sometimes heated in a kiln, it is not possible to completely remove the cellulose from the remainder of the grain. Small, sharp particles remain, which although in some instances irritating to portions of the alimentary canal, still have the advantage of stimulating intestinal action.

Composition of Oatmeal

A typical oatmeal found on the market has the following composition:

	Per cent.
Water	7.8
Protein	14.7
Fat	6.2
Carbohydrates including starch, sugar, dextrin and cellulose.	69.8
Mineral matter	1.5

Oatmeal is unique among the cereals in the amount of protein, and fat contained. Of the nitrogenous matter, 94 per cent. is in the form of protein, so that it can be readily digested, although experiments are wanting to show exactly how large a proportion really is available as food in the human system. These proteins consist of *avenin*, sometimes called oat myosin, oat legumin, or oat casein, and a small quantity of oat gliadin. The avenin is similar to the legumin of peas although it contains more sulfur. Oats contain more fat than wheat, although it is of the same character. The mineral salts are also abundant and of great value in the process of nutrition.

Cooking Oatmeal

In order to be fully digested, oatmeal should be cooked longer than the thirty to forty minutes usually suggested. Digestion experiments recently made[1] show that when oatmeal is cooked for four hours or more, the diastase ferment acts on it more readily, and it is more easily digested than when cooked for thirty minutes. For those of feeble digestion, long cooking of oatmeal is positively necessary, otherwise gastro-intestinal irritation will result. That the oatmeal, as served at hotels and restaurants, is often very imperfectly cooked, is evident both from the taste and appearance. As there is no gluten in oats similar to that in some other grains, ordinary bread cannot be made from this cereal, but it has been used mixed with wheat and rye flour to make a very nutritious bread of fair quality. Oats can be cooked most thoroughly and completely in the form of porridge, because the heat is so much more readily applied to all portions of the mass.

Oatmeal as Food

Since oatmeal is such a richly nitrogenous and "hearty" food, it is important, if the health be preserved, that those who make it a large portion of their diet live much of the time in the open air.

[1] Minn. Exp. Sta. Bull. No. 74.

The Scotch Highlanders are often mentioned as a race who have been nourished on this remarkable food. The Scotch "Groats" is the kernel freed from its outside covering and then ground without the removal of the germ. For the genuine product the grain is heated or parched for several hours over perforated iron plates, before it is ground. The product known as "rolled oats" has been upon the market for some years. It is claimed that the great pressure applied, and the heat employed during the process, rupture the cell walls and break down the cellulose, so that the subsequent preparation for the table requires less time than if other methods were used in the manufacture.

Some manufacturers claim that by some special process of manufacturing, their product is vastly superior to others, but there is no reason why the consumer should pay more than from 4 to 7 cents per pound for a good wholesome oatmeal. Package goods have the advantage of protection from dust and dirt, and they are perhaps less liable to be infested with insects than bulk goods. Oatmeal, on account of the large amount of fat contained and the character of the protein, does not keep very well, and is liable to become musty. It is also quite liable to be infested with insects. This cereal is not often adulterated, because most adulterants would be too expensive. A mixture with the meal of other cereals can readily be detected by the use of the microscope.

BARLEY (Horedum sativum, Pres.)

This cereal, probably a native of western Asia, it is asserted has been known in China and in Egypt for centuries. There is evidence to show that it was grown in central Europe a thousand years ago, and in the palmy days of Greece and Rome, barley was cultivated extensively, especially as food for horses. Barley meal was at one time the most important food of the people of the north of Europe, and of parts of England and Scotland. In 1626, and later, barley meal was the common food of laborers in England, and as late as 1858 barley is spoken of as the common food of the people living in the mountainous districts of Sweden, Switzerland and Scotland.

In most countries barley has gradually been replaced by wheat, as the latter is transported all over the world, and it no longer becomes necessary for people to live exclusively on the foods that are produced in their immediate vicinity. Barley is grown in almost any latitude in the United States, the method of cultivation being similar to that for wheat or rye. The yield per acre exceeds that of most other grains.

Composition of Barley

The following is the composition as reported by Atwater:

	Pearl barley	Barley meal
Water	11.50	11.90
Protein	8.50	10.50
Fat	1.10	2.20
Carbohydrates	77.80	72.80
Cellulose	0.30	6.50
Ash	1.10	2.60

Barley contains a relatively large amount of mineral salts, fat and undigestible cellulose, but contains less protein and less digestible carbohydrates than wheat. Osborn[1] divides the protein of the whole barley grain, which amounts to 10.75 per cent., as follows: Leucosin (albumin) 0.3 per cent.; proteose and edestin (globulin) 1.95 per cent.; hordein, similar in physical and chemical properties to gliadin, 4 per cent.; and insoluble protein 4.5 per cent.[2]

[1] Am. Chem. Jour., 1895, 17, pp. 539–567.
[2] See also Chem. Study of Am. Barleys and Malts, U. S. Dept. Ag. Bur. Chem. Bull. No. 124.

Uses of Barley

As barley contains no gluten it does not make good bread but mixed with an equal quantity of wheat flour a product of fair quality can be made. The meal has been used for making "barley cakes," from the earliest times. Barley water has been found to be an excellent demulcent and cooling drink for invalids, although the amount of nutriment contained in it is less than 1 per cent., and is, of course, almost negligible. Pearl barley, which is the whole grain polished by attrition after the removal of the husk and germ, and products of this class, similar to oatmeal preparations, require long boiling—from one to two hours—in order to permit of their easy digestion. As an addition to soups barley finds great favor.

Aside from its use in feeding horses and cattle, the chief use of barley is in the manufacture of beer and alcohol. *Malt*, which is another name for sprouted and dried barley, has the property of converting the starch into fermentable sugar on account of the amount of diastase which it contains. Malt is also used with an infusion of other grains in making neutral spirits (alcohol), and in making whiskey and other alcoholic beverages. (See p. 143.) *Malt extract*[1] is a dietetic preparation which is obtained by macerating powdered malt for six hours with water, diluting and digesting below 131° F.; then strain and evaporate on a water bath or in vacuo to a syrupy consistency. Malt extract consists mostly of maltose, invert sugar and dextrin, with from 6 to 8 per cent. of protein, and is a highly concentrated food which, on account of the diastase which it contains, assists in the digestion of starchy foods.

CORN (Zea mays)

History

Although Indian corn was not known to the civilized world until the discovery of America, it has gradually increased in impor-

[1] U. S. P., p. 141.

tance so that to-day, in the United States at least, it stands next to wheat as a cereal used for the food of man. The progenitor of our modern corn[1] was a plant of the grass family, growing wild on the plateaus of Mexico and Central America thousands of years ago. It can be grown anywhere in the temperate zone, but it has not until recently been extensively cultivated, except in the western hemisphere. At the time of the potato famine in Ireland corn was imported into that country, and since that time has held a very important place as a cheap food material.

Importance of the Corn Crop

Corn may be said to be the most important agricultural crop in the states of Indiana, Illinois, Iowa, Missouri and Kansas. In the United States it far exceeds wheat in the size and value of the crop produced.[2] There were 30 acres of corn grown in the James River settlement in 1611: there were 105,825,000 acres grown in the United States in 1911. In the southern United States corn and its products are much more extensively used as human food than in the north. It has found its way rather slowly into the diet of the Europeans, except in Italy, although it could readily replace more expensive foods.

Cultivation of Corn

There are a number of varieties[3] of corn grown, which may be distinguished as husk-kernel corn, pop corn, flint, dent, soft and sweet corn. Some of these are peculiarly adapted to particular localities and climatic conditions, and others will grow almost anwhere. Ordinary corn has been much improved in quality and nutritive value by judicious selection and cultivation. To cultivate the crop successfully, an abundance of rain during the growing season is required. The hills in which three or four stalks grow

[1] Pop. Sci. Monthly, Vol. 82, p. 225.
[2] Maine Ag Ex. Sta. Bul. No. 131.
[3] Foods and Their Adulteration, Wiley, pp. 224–225.

are about 4 feet apart, and the ground must be cultivated several times, and kept free from weeds. On the prairies of the middle west of the United States, the yield is sometimes as high as 110 bu. to the acre, and there are occasional stalks measuring 16 feet in height, so rich is the soil, and so ideal are the conditions for the growth of the plant. On account of the hard, flinty nature of its outside covering, corn keeps well if stored in a dry place. The structure of the grain or kernel is shown in Fig. 5.

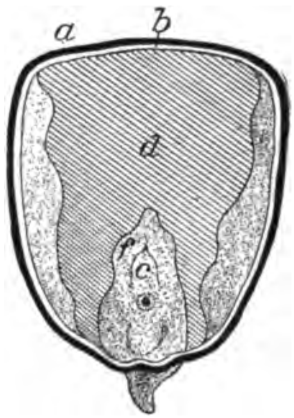

FIG. 5.—Structure of the corn grain. By permission, U. S. Dept. Agric. *a*. Wall of the ovary; *b*, testa; *c* and *f*, embryo; *d*, starchy embryo. Outside of *d* is a mixture of starch and aleurone.

Milling of Corn

Corn meal, the chief manufactured product, is prepared by the simple grinding of the corn, and bolting more or less completely. By modern milling operations, not only is the bran completely removed, but to a large extent the germ itself, and thus as most of the fat is removed the meal is better adapted for export purposes. The meal is also kiln dried to destroy any bacteria that may be present and to remove some of the moisture. The color of the product will depend on the color of the corn used, but there is no practical difference, as far as nutritive value is concerned between yellow and white corn meal. The "nutty" flavor of the white corn, and the peculiar flavor of the yellow corn, are due to the presence of certain volatile bodies largely retained by the fat. The refined[1] product found on the market, which has been so treated as to lose much of the mineral matter, fat and protein, is less nutritious than the ordinary meal, and some of its characteristic flavor, which is much appreciated by many, is lost.

[1] U. S. Dept. Agri. Bur. Chem. Bull. No. 151.

Composition of Corn

The average composition of corn is

	American corn[1]	Sweet corn[2]	Corn meal[1]
Water	10.95	8.40	12.57
Protein	9.88	11.48	7.13
Fat	4.17	8.57	1.33
Carbohydrates	71.95	66.72	78.36
Cellulose	1.71	2.82	0.87
Ash	1.36	1.97	0.61

The chemical analysis shows that corn is rich in fats,[3] although somewhat deficient in protein and mineral salts. The following is given as the composition of the proteins by Osborne.[4] Zeins, solubles in alcohol, 5 per cent.; insolubles, 3.14 per cent.; globulins, 0.39 per cent.; albumins, 0.06 per cent.; making a total of 8.59 per cent.

Corn Oil

The oil of corn, sometimes called "oil of maize," consists of oleate, palmitate, and stearate of glycerol. Commercial corn oil is prepared from the germ which is removed from the corn by some processes of milling, and in the process of making glucose. (See p. 118.)

Cooking Corn

As corn does not contain a true gluten like wheat, it cannot be used for making an ordinary bread raised with yeast. There are numerous ways in which corn meal is prepared as food. The

[1] U. S. Dept. Agri. Div. Chem. Bull. 50.
[2] Richardson.
[3] For prop. and comp. of corn oil, see J. Am. Chem. Soc., Vol. 23, p. 1-8.
[4] J. A. C. Soc. 19, p. 525, also Osborne, Loc. cit., Vol. 13, Vol. 14.

product made by boiling the meal with water is called *stirabout* in Ireland, *polenta* in Italy and *mush* or *hasty pudding* in the United States. When the meal is baked in cakes it is known as *johnny cake* (said to be a corruption of journey cake). "Ash cake" is made by wrapping the dough in cabbage leaves and baking in hot ashes. In the Southern States the cakes are known as *corn pones* or *hoe cake;* in Mexico and South America as *tortilla* (*tortio*). These are of course all unleavened products, made by simply mixing the meal with water and salt and baking in the most primitive way.

Corn bread can be made by the use of baking powder or baking soda and sour milk. The meal is sometimes mixed with an equal quantity of wheat or rye flour. The best corn bread is made from the freshly ground corn meal.[1]

Sweet Corn

Sweet corn furnishes an excellent food product during three or four months of the growing season, and has become of great importance as a canned food. It compares favorably with the potato in food value, having 73 per cent. of water, while the potato contains 75 per cent.; sweet corn contains 13.5 per cent. of starch; 6.00 per cent. of sugar, and 5.00 per cent. of protein. The fresh potato contains only 1.20 per cent. of protein. Corn may be boiled "on the cob" or cut from it, or it may be roasted, but in any case it is eaten hot. (See succotash, p. 195.)

Canned Sweet Corn

In the United States canned sweet corn has become almost a family necessity. It is of better quality for canning when grown in the north, and the principal canneries are located in Maine, Maryland, New York, Indiana, Michigan, Iowa and Wisconsin. No less than 7,447,765 cases (of twenty-four cans each) of corn were canned in 1909.[2]

[1] Farmers' Bull. No. 565.
[2] Maine Agri. Exp. Sta. Bull. No. 131.

It happens unfortunately that there are opportunities and an incentive to adulterate sweet corn, and so it was formerly found bleached with sodium sulfite, to make it white, or sweetened with *saccharin*, or at least sweetened with cane sugar, instead of being canned in its natural state. Saccharin has a sweetening power nearly 500 times that of sugar, and it was much cheaper to use it than cane sugar. Saccharin is made from coal tar and is what is called a *synthetic* compound; its use in any food product is positively forbidden in United States. It has no food value as has cane sugar, and we do not know but that its effect on the system may be injurious. Cane sugar even is an adulterant, and when used its presence should be stated on the package. Corn flour or starch is also added to inferior grades of canned corn to give the product the appearance of being thick and creamy.

Pop Corn

Pop corn (Zea everta) is peculiar from the tendency of its kernels to turn inside out upon heating. It differs from the ordinary flint corn in having a larger porportion of corneous endosperm or horny substance associated with the starchy portion of the kernel.[1] The ears and kernels of pop corn are small and the whole plant is diminutive compared with other varieties. The kernels may be red yellow or white, but there is less demand for the colored varieties. The white rice corn is the variety most in favor. More than 280,000 bushels are grown annually in the United States, the largest producers being the states of Iowa and Nebraska.

The cause of the popping of corn is supposed to be the expansion of the moisture contained in the starch cells. The seed coat should be sufficiently hard and dry to afford considerable resistance to the expansion, otherwise the corn does not pop well. For popping the corn should contain about 12 per cent. of moisture, and if properly stored it will retain this quality for several years. Pop corn is not ready for marketing until the summer following the season in which it is grown.

[1] U. S. Dept. of Agri. Farmer's Bull. No. 554.

Pop corn is used more as a confection than a food, but it is at the same time wholesome and nutritious. The principle products are pop-corn balls, corn bar, sugar-coated pop corn, pop-corn bricks, and "crackerjack," which is a mixture of pop corn and peanuts held together with sugar and glucose.

Corn Flour as an Adulterant

The mixing of corn flour with wheat flour is considered an adulteration in the United States, but this mixture is allowed if the fact is stated on the package and when a small revenue tax is paid.

Pellagra not Caused by Eating Corn

There is a disease called "Pellagra," which was at one time supposed to be caused by eating moldy or fermented corn. It was reported from Spain nearly 200 years ago and has been prevalent in parts of France and Italy, for many years, but only recently has it attracted much attention in America, and that in the Southern States. More recent investigations throw very serious doubts on the assumption that there is any relation between a corn diet, and this disease. Corn has been in use for generations over vast areas without causing the disease, and people have pellagra who do not eat Indian corn.[1]

Food Values of Corn

Wiley[2] says—"There is a widespread opinion that the products of Indian corn are less digestible and less nutritive than those from wheat. This opinion, it appears, has no justification either from the chemical composition of the two bodies, or from recorded digestive or nutritive experiments. In round numbers corn contains twice as much fat or oil as wheat, three times as much as rye,

[1] Independent, N. Y., Vol. 74, p. 874.
[2] U. S. Dept. Agri. Div. Chem. Bull. No. 13, pt. 9, p. 1290.

twice as much as barley, and two-thirds as much as hulled oats. Indian corn has nearly the same content of nitrogenous matters as the other cereals, with the exception of oats." Corn is an excellent food, and in general easily digested. Sweet corn sometimes causes irritation in the intestines on account of the presence of the tough exterior coating which resists digestion.

Corn Starch

Corn starch, which is so extensively used in the preparation of puddings and for infants' food, is one of the most important corn products. In the use of corn starch, under whatever name sold, it should not be forgotten that the product is nearly pure starch, and to form a satisfactory balanced ration its use should be supplemented with foods rich in nitrogenous material and fat. Corn starch is a common adulterant of the more expensive starchy foods, such as sago and arrow root.

The increase in the use of corn, in the life of the far East, bids fair to be an important economic factor. Indo-China and the Philippines have begun raising corn in the place of rice and millet. In the Philippines, a campaign of education, begun by the U. S. Dept. of Agric., is beginning to bear fruit. The crop seems well adapted to this climate, and 2 or even 3 crops are raised annually. It is believed that the raising of corn will do much to improve the condition of the natives, as it renders them less liable to a famine when the rice crop fails.[1]

RICE (Oryza sativa)

Rice is a native of India and southern China, and has been known in Asia as a food product from the earliest times, in fact there is evidence of its being in use in China as early as 2800 B. C. It is grown principally in the East, in southern Europe, in the West Indies, and the southern Atlantic and Gulf States. It was intro-

[1] D. Cons. Tr. Rep. U. S., 1913, No. 254.

duced into the United States in 1694, and its cultivation is rapidly extending especially in Louisiana, Texas and Arkansas, which three states now furnish three-fourths of all the product of the country. Before the Civil War of 1861–65, North Carolina, South Carolina and Georgia were the principal rice-producing states.

Use of Rice

This cereal, which is extensively used by the people of China, India and Japan, is said to form the principal food of one-half of the human race,[1] and is an important addition to the food material in all civilized countries. Notwithstanding the large amount grown in the United States we annually import from foreign countries five times as much as we raise, and on this amount there is a tariff of one cent per pound.

Cultivation of Rice

More than 100 varieties of rice are grown, but the principal ones grown in the United States are the "gold seed," the "white" rice, and the Honduras rice. Through the efforts of the U. S. Dept. of Agric. in 1899, a short-kerneled variety known as Kinshu rise was introduced from Japan. This is considered more productive than the other varieties, and does not break so readily in the milling and polishing.[2]

Rice grows best in damp soils, especially those underlain by a semi-impervious sub-soil, and in localities where it can be flooded at certain seasons. During the germination and growth of the crop the water is allowed to flood the field several times, but between times the field is allowed to dry so that the crop, which is usually planted in drills, can be hoed. (Fig. 6.) The final irrigation is allowed to continue until about eight days before the harvest. Where the ground is sufficiently firm, reaping machines

[1] U. S. Dept. Agri. Farmers' Bull. No. 417.
[2] U. S. Dept. of Agric. Farm Bull. No. 110.

FIG. 6.—A rice field. (By permission, Central Scientific Co.)

FIG. 7.—Hulling rice in Burmah.

are used in harvesting the rice; otherwise it must be cut with the sickle.

Milling

When the grain comes from the thresher it is known as "paddy" or rough rice, from which the hull is afterward

FIG. 8.—Large stones for hulling rice, and removing chaff. Savannah, Ga. (Copyright by Keystone View Co.)

separated. This operation, in the primitive way, is accomplished by the use of a large mortar and pestle (Fig. 7) but in modern practice a "hulling machine" has been devised which expedites the work. (Fig. 8.)

For many years, the rice, as prepared for market by the simple process of hulling, was considered satisfactory, but there arose a seeming demand for a whiter and more highly polished product.[1] As a result elaborate machines are in use in the rice mills of the South, and elsewhere, in which, by means of leather rollers the outer layer of the rice is rubbed off. (Fig. 9.) In this outer layer lies most of the nutritive material, other than starch, and the slender grains of some varieties of starch are also broken in this process. In 100 pounds of rice polish (the material removed)

Fig. 9.—Polishing rice, Savannah, Ga. (Copyright, Keystone View Co.)

there are 7.2 pounds of fat, while only 0.4 pounds per hundred are retained in the polished rice. The practice of polishing,[2] however, is still continued, and thus the best part of this important food is separated to be used as food for stock, instead of being retained to enrich the grain to which it belongs. This practice is on par with the bleaching of wheat flour, another process which by many is

[1] Food materials and their adulteration, E. H. Richards, p. 72.
[2] See Nat'l Geog. Mag., April, 1906, p. 3 (quoted by Richards).

thought to deteriorate the quality of a wholesome food, simply to make it more salable or whiter and more pleasing to the eye. It has been claimed that the disease known as "beri-beri" is due to the use of polished rice, but this subject is still under investigation.[1] In a recent investigation made in Calcutta it was shown that the polished rice and wheat used by those natives who were afflicted with this disease was lacking in such an important ingredient as phosphorus. Pigeons fed on the polished rice showed loss of weight, while control pigeons fed on foods containing a larger amount of phosphates remained in good health.

The loss by breakage in the process of milling and polishing, is from 25 per cent. to 60 per cent. While the whole grains sell for 6 cents a pound, the broken grains sell for about half that price, and the smaller particles for less than 2 cents, yet all is equally valuable as food. The broken rice, however, does not make as acceptable a dish when cooked as do the whole grains.

Composition of Rice

The average composition of rice is as follows:[2]

	In the husk	Hulled	Polished
Water	10.50	12.00	12.40
Protein	6.80	7.20	6.90
Fat	1.60	2.00	0.40
Starch, sugar and gum	68.10	76.80	77.40
Cellulose	9.00	1.00	0.40
Ash	4.00	1.00	0.50

Rice is poor in proteins and fat, and therefore is not suited to form the sole food of any individual or nation. As it contains only 6 to 8 per cent. of protein and usually less than 1 per cent. of ether

[1] Phil. Jour. Sci. B, Med. Sci. 6, p. 229.
[2] U. S. Dept. Agric. Bur. Chem. Bull. No. 45.

extractive (mostly fat), rice should be served with eggs or milk as in puddings, or with meat, fish or peas, to furnish a well-balanced ration. It is most economically utilized when cooked in soup, as whatever mineral salts and nutritious substances may be present are then used.

Rice as Food

It is a mistake to suppose that the people of various Asiatic nations, who eat enormous quantities of rice, subsist wholly on this diet. Careful investigations at the Japanese village in the World's Fair in Chicago in 1893 show that in the diet of these people rice is supplemented by potted fish-roe, ducks' livers, fresh and dried fish, hard-boiled ducks' eggs, chicken or some food containing proteins. In those countries where rice is so much used, peas, beans and soy beans grow luxuriantly and are also used to supplement the diet. These protein-yielding foods are used with great economy, and not carelessly thrown away, as is too often the custom in the United States.

Cooking Rice

The starch grains of rice are small and of different construction from those of other cereals, and partly on this account, rice does not need so much cooking as oatmeal and some other grains. As it absorbs nearly five times its weight of water when cooked,[1] and as much of the mineral matter would be lost by boiling with water, rice is better cooked by steaming. By this process, as used in the South especially, each individual grain is allowed to swell and the product consists of the whole grains, well softened.

Digestion

Rice is easily digested, though not as fully as some grains which are ground to a fine flour. It is finally absorbed very completely

[1] Food and Dietetics, Hutchinson, p. 220.

in the intestines, so that practically all the starch is utilized. On this account rice has long been regarded as an excellent food for invalids and convalescents. If we regard rice as consisting wholly of carbohydrates, since it is richer in starch than any other cereal, an adult would require 1 pound and 3 ounces daily, or about 5 pounds of cooked rice.

Adulteration

Rice admits of adulteration by coating or glazing with a mixture of glucose, paraffin and talc. This treatment is said to give it a better appearance, and to protect it from insects. Such additions, especially of the mineral substances paraffin and talc, both absolutely indigestible, are considered adulterations, and are not permitted by the U. S. Food Inspection decisions.[1]

Rice Products

There is a rice flour upon the market made by grinding the broken and imperfect grains, which although not suitable for making bread, finds numerous uses. Rice starch is made by heating rice flour with an alkaline solution to dissolve out the nitrogenous matter, and then allowing the starch to deposit according to the ordinary methods for making starch. Another very important use for the broken grains is as "Brewer's rice," which is used with malt, rye and other grains in the manufacture of some varieties of beer. (See Alcoholic Beverages, p. 136.)

MILLET (Panicum miliaceum)

This cereal is not used in the United States as food for man, although it is raised for stock food. It is said to be the staple diet of the negroes of the Upper Nile, and is used in southern Europe, in India, China, Japan and Korea, and in fact it is estimated to feed one-third of the inhabitants of the earth.[2]

[1] U. S. F. I. D. No. 67, also, N. D. Agri. Ex. Sta. Bull., Vol. 2, No. 1.
[2] Foods, Origin, Manufacture and Composition, Tibbles.

Composition of Millet

The analysis shows that it contains, in addition to the starch, 10 per cent. of protein and about 4 per cent. of fat.[1] Bread made from millet is nutritious and palatable when fresh, but soon becomes darker in color and crumbles readily. It occupies a place between wheat and rice in protein value. There are numerous varieties of millet, as durrha, sorghum-grass, and Indian millet. The seeds of the sorghum (sorghum saccharatum) furnish a starchy food, which has been used to a limited extent only. The seeds of the durrha are ground into a dark flour and used in Africa and the East for making bread. The sorghum[2] stalk is used in the United States, for making sorghum sirup (see p. 124) and in China for making alcohol.

BUCKWHEAT (Polygonum fagopyrum)

This grain, although not a cereal, may conveniently be considered here. It was introduced into Europe from Manchuria and central Siberia and is at present grown in Russia, Brittany, Holland, and the United States. It is not of very ancient origin, as it was not introduced into Europe until the Middle Ages. In the United States the cultivation of buckwheat is carried on chiefly in the New England States, New York, Pennsylvania, and Michigan.

The seed is sown in the late spring or early summer and the grain matures very rapidly; often in 100 days. The abundant and very odoriferous white flowers furnish to the bees a dark honey of peculiar flavor, which does not command in the market as high a price as the honey made from other flowers.

Composition of Buckwheat

The brown, three-sided buckwheat grain contains from 11 to 15 per cent. of protein, 3.6 per cent. of other extractive, and

[1] Bull. U. S. Dept. Agri. No. 45.
[2] U. S. Dept. Agri. Div. Chem. Bull. No. 37, p. 75.

63 per cent. of carbohydrates.[1] The flour which is dark in color may be made by grinding the grain between stones and separating the principal part of the hulls by bolting, which is the old-fashioned way, or a finer grade of whiter flour may be made by the use of elaborate machinery.[2] In the former case the flour is more nutritious and furnishes a more palatable product, but it is not as white. The color may be regulated by allowing more or less of the inner hulls (middlings) to pass into the flour.

Cooking

Buckwheat flour is used, especially in Holland and the United States for making griddle cakes. The dough is raised with yeast, for the flour contains enough of a glutenous substance to entrap the bubbles of gas, and the "batter" is usually allowed to stand over night. The "leaven" left over from one batch is used to start the fermentation in the next. Buckwheat cakes are often eaten with sirup, especially maple sirup, and are always served hot. The "self-rising" buckwheat flour on the market is the flour mixed with a little salt and some baking powder (usually an alum powder, as this is the cheapest). Buckwheat is used in Brittany for making a bread called "black bread" and in Holland and France for making porridge: It is also useful for feeding stock and poultry.

Adulteration

Buckwheat flour has often been adulterated with corn flour or a low grade of wheat flour, in order to cheapen the product. This does not in any way decrease the nutritive value of the flour, but this falsification is, of course, a fraud upon the consumer, and can be readily detected by the use of the microscope, as the starch granules in buckwheat have a characteristic appearance.

[1] U. S. Dept. Agric. Bull. No. 13, pt. 9.
[2] Foods and Their Adulteration, Wiley, p. 220.

QUINOA (Chenopodium quinoa)

The quinoa (kí-no-a) seeds, which are practically unknown outside of South America, form a staple food among the inhabitants of Chile, Peru and New Granada. The plant is an annual herb, which grows to the height of from 4 to 6 feet and will flourish at an elevation of 13,000 feet above the sea level. The flour is made into unleavened cakes, or the seeds are eaten in soup. The flour contains a high per cent. of protein, and a moderate amount of fat in addition to the starch.

KAFIR CORN

Kafir corn was introduced into the United States from South Africa in 1876.[1] It has been for a long time a staple food in Africa, India and China, but has been little used for that purpose in this country. On account of its drought-resisting qualities, it can be raised in some semi-arid places where it is difficult to raise Indian corn. It differs but little in composition and digestibility from the latter, but its flavor is somewhat stronger. Kafir corn meal requires longer cooking than does Indian meal. (See "Uses of Sorghum Grains," Farmers' Bull. No. 686.)

CEREALS RAISED IN THE UNITED STATES IN 1915

	Bushels
Corn (maize)	2,985,000,000
Wheat (winter and spring)	981,000,000
Oats	1,408,000,000
Barley	223,000,000
Rye	44,000,000
Rice	26,000,000
Buckwheat	18,000,000

According to the report of the Dept. of Agri.[2] the United States in 1910 produced the following proportion of the world's

[1] U. S. Dept. Agri. Farm. Bull. No. 559.
[2] Circ. 31, Bur. Statistics.

staple cereals: Of corn 71.7 per cent.; wheat 17.7 per cent.; oats 24.1 per cent.; barley 11.6 per cent.; rye 2.1 per cent.; rice 0.5 per cent. The United States stood first among the nations in the production of corn, wheat and oats, and second in the production of barley.

THE MANUFACTURE OF STARCH

Nearly all the commercial starch is manufactured from wheat, corn, potatoes, cassava and rice.[1] In the United States five-sixths of the starch is made from corn and one-sixth from other sources. The starch from potatoes is used especially in the textile industries, although corn starch is now recommended for this purpose,[2] while that from cassava is used as tapioca, a special food product. In Europe potatoes are the principal source for the manufacture of starch while in the tropics cassava is used for this purpose.

Wheat Starch

There are two methods used in the United States for making starch from wheat. In one process the dough is thoroughly mixed and the starch washed out by the use of a suitable machine. The gluten which is thus separated out is dried and put on the market as "wheat gluten." In the second process the flour, after being mixed with water, is allowed to ferment, and the starch is separated out by allowing the liquid to run over shallow tables where the gluten runs off as a thin fluid, and the starch settles to the bottom.

Corn Starch

From the manufacturer's standpoint there are five valuable constituents in the corn kernel, namely; starch, gluten, germ, oil and bran. To obtain these products the corn is soaked in

[1] The Twelfth Census of the United States, Vol. 10, Manufactures, Part IV, p. 745. Special Report of the Census Office, Manufactures, Part III, 1905. The Twelfth Census of the United States, Vol. 9, Agriculture, Part III, p. 573.
[2] J. Ind. and Eng. Ch. 1912, p. 417.

warm water with the addition of a small amount of sulfurous acid to loosen the intercellular tissue and prevent fermentation. The corn is then ground in such a way as not to break or crush the germ and the ground material is run into the "germ separators" where the germs being lighter than the other material, are floated off and the husks sink to the bottom. The germs are washed from the adhering starch in shakers or sieves. They are then dried and the mass is pressed to extract "corn oil" and leaving "germ cake." The "germ oil meal" which is prepared by grinding the "germ cake" is a valuable cattle food, containing about 24 per cent. of protein and 10 per cent. of fat. The "corn oil" finds many uses in the arts and a large amount is exported.

The starchy material separated from the germs is ground very fine and passed over bolting-cloth sieves. The bran which remains on the screens constitutes a valuable stock food. It is sometimes mixed with water and sold as "glucose feed" or "slop" for immediate consumption. The starch and so-called gluten which is passed through the sieves is mixed with a sufficient quantity of water and the liquid is allowed to flow over level tables, frequently 100 feet long, where the starch settles out of the liquid and the gluten passes on. After a sufficient quantity of starch is settled out it is removed from the table placed in sacks and dried in kilns. The starch is then broken up, ground, and put upon the market as either laundry starch or edible starch, known as "corn starch." The starch prepared in this way, while still moist, may be mixed with water and used as the basis for making glucose, grape sugar, etc. (See p. 118.) The gluten which flows off from the starch is allowed to settle, then dried and put upon the market as "gluten meal" and from it a food-stuff suitable for human consumption can be manufactured.

Potato Starch

Maine and Wisconsin are the principal states where starch is manufactured from potatoes. The culls are used for this purpose and are purchased at from one-third to one-half the cost of the marektable potatoes. The process of manufacture is quite simple and in fact is one than can readily be imitated in the household. For this purpose the potatoes, after being peeled, are grated upon an ordinary tin grater, the pulp is pressed through cotton cloth and the milky liquid which runs through is allowed to stand over night when the starch settles to the bottom of the vessel and after carefully pouring off the liquid and washing several times by decantation, the starch can be taken out and dried.

For manufacturing potato starch on a large scale[1] the potatoes are first washed, then put in a scraping machine which consists of a wooden drum upon which are nailed pieces of sheet iron punched full of holes, with the rough edges facing outward—in fact, a surface practically like the ordinary grater. This drum revolves rapidly and the potatoes being held in place at the bottom of the hopper by a brace of hard wood, are quickly reduced to a pulp, which is carried along by a stream of water which flows into the hopper.

From the scraping machine the pulp runs on to a starch separator, which consists of a rectangular box, having wire gauze on the bottom with openings about 1/60 of an inch in diameter, and so arranged that it can be shaken like a sieve. This separator is slightly inclined and as the pulp is carried in with water and washed with jets of water, the attached starch granules are washed through the meshes of the sieve, and the pulp is carried on to the end of the sieve where it is discharged. The pulp is sometimes fed to stock.

The milky liquid then goes into tanks 40 feet long and 8 feet deep, where in a few hours the starch settles to the bottom, and the reddish liquid above is drawn off. This crude starch is then put into the "starch washer," where it is agitated with more water, and allowed to settle again. When the water has been drawn off, it is found that the pure starch at the bottom is covered by a thin layer of starch mixed with impurities and this layer is drawn off and washed again.

[1] U. S. Dept. Agri. Division of Chem. Bull. No. 58.

The starch must then be dried, which is done either with hot air or by steam heat in special kilns. These are provided with racks upon which the starch is piled in such a way that as it becomes drier it falls from one rack to another, and so is not heated enough to cook the starch grains. Potato starch is especially valuable for use in print works.

Cassava Starch

While the chief use for cassava may be in the preparation of tapioca and flour, it is becoming valuable as a commercial source of starch. The fresh roots contain from 24 to 28 per cent. of starch.[1] By the process used the factories can only secure about 20 per cent. of the starch and a considerable quantity remains in the refuse, which is utilized for cattle food. The cassava grown in sub-tropical regions, as in Florida, does not contain as much hydrocyanic acid as that grown farther south.

In the manufacture of starch from cassava, the same machinery and method is used as with potatoes (p. 58). As the per cent. is larger in cassava, the yield of starch is greater than from potatoes. A few factories in Florida and Mississippi are engaged in this industry. It has been recently pointed out[2] that cassava is a much cheaper source of starch than corn or potatoes. In Florida the corn grown on one acre will produce 1200 pounds of starch, while the cassava grown on the same area will produce 5600 pounds of starch. At present their product is practically all purchased by cotton factories where it is used for sizing and laundry purposes. Starch from tapioca, sago, etc., costing $1,973,809, was imported in 1912. (See p. 161.)

Microscopic Examination of Starch

To distinguish between the starches from different sources it is necessary to use a good microscope, and a "polarizer" is a convenient attachment. The grains from different sources when

[1] U. S. Dept. Agri. Farmers' Bull. No. 167.
[2] Jour. S. Ch. Ind., 22, p. 63.

measured will be found each to have a different size, and will each have a characteristic appearance when viewed by normal and by polarized light. (Fig. 10.) It is by these tests that it is possible

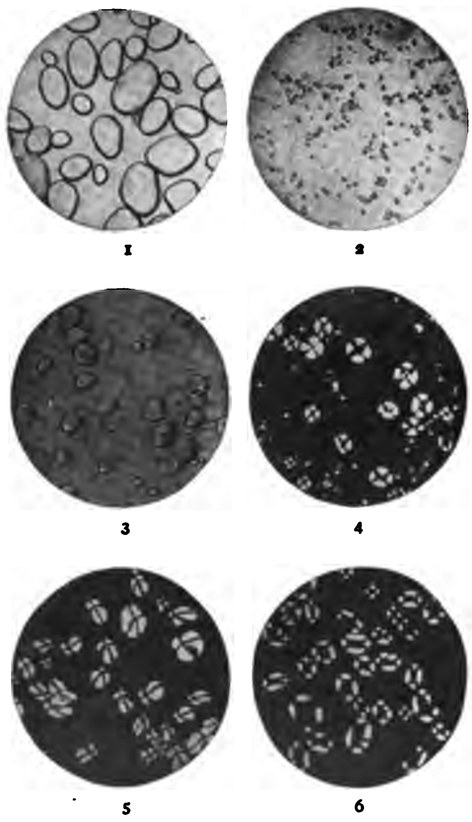

FIG. 10.—Some common starches. (Yearbook U. S. Dept. Agric., 1907, by permission.) 1, Potato starch.; 2, rice starch; 3, wheat starch; 4, wheat starch with polarized light; 5, maranta starch—polarized light; 6, bean starch—polarized light.

to detect the adulteration of an expensive starch with a cheap product, and to detect substitution, as for instance the mixture of corn flour with buckwheat flour.

Digestibility of Different Starches

Much investigation has been carried on upon the digestibility of starches from different sources.[1] Raw starch digests much more slowly than starch in the form of paste. "Potato, arrowroot and probably tapioca and sago starch pastes are not made more easily digestible by long cooking. On the other hand the cereal starches are made more digestible by long cooking though the change occurs very slowly. . . . . However, in the case of starch still inclosed in cellulose walls, as in many starchy foods, the long-continued cooking may be necessary. The commercial preparations of corn starch require 30 to 40 minutes cooking because of the improvement of flavor which results."

[1] Day. U. S. Dept. Agri. Of. Exp. Sta. Bull. No. 202.

CHAPTER III

BREAD AND OTHER CEREAL PRODUCTS

BREAD AND BREAD-MAKING

History

In making edible foods from the cereals or their products, various methods for grinding the grain, for making the dough light and for baking have been in use from the earliest times. In the primitive stages of the civilization of all peoples, their methods have been very crude and imperfect, but as bread of some kind has so long been the most important food of the race, the improvements in the methods used for preparing bread, have kept pace with the advancement of the race toward civilization. References to bakers, and baking are numerous throughout the earlier literature: not only the writings of the Jews but those of the Egyptians and Romans, are full of these references. In 170 B. C. baking became a regular trade in Rome. The use of fermented bread was no doubt carried to Britain by the Romans, but strangely enough they seem to have returned to unfermented bread after the Romans left England. Wine "must" was very early used in Greece and Rome, and "barm" from beer in Spain.

Going back to the earliest times, both leavened and unleavened bread were used. The simplest product would, of course, be that which was unleavened, but as the mixture of flour or meal and water undergoes spontaneous fermentation, deriving yeast and other organisms from the air, it would not be long before this fact would be taken advantage of to produce a light bread of different texture and flavor from that which was baked as soon as mixed. The next step to allowing the dough to stand for some time and become sour, would be to add some of the sour dough or "leaven" to the fresh batch of dough to induce fermentation. Thus it is evident that the whole process would be gradually evolved through experience.

The making of bread is possible because of the presence of gluten in the flour. Gluten is a protein or mixture of proteins, which becomes viscid or sticky when mixed with water, and this mass may then be blown up with air or any other gas, and finally the mass *sets* in this condition in the process of baking. If the walls of the cells are not stable enough to stand, when the gas has been expelled by heat, the bread falls, or is said to be heavy.

Unleavened Bread

This bread is prepared by simply mixing the ground, crushed or bolted flour with water and salt and baking before a bonfire, in the ashes, or on a pan in the oven. No attempt is made at "aeration" or making the product light. The Passover cake of the Isrealites, sea biscuit, and hard tack as used on ship-board and in the army, the Scotch oat cake and the corn-meal "pone" are examples of this kind of bread. Graham flour and whole-wheat flour are often prepared in this way in dietary establishments.

"Biscuit" as they are sometimes called, or "crackers," are made either from the leavened or the unleavened dough. (See p. 83.) "Hard tack" is rapidly baked, and while in the oven the generation of steam and the expansion of the starch causes it to rise slightly. After being baked it is stored in a warm room for a week or two to "cure" and dry, and in this condition, will, if dry, keep for years without deterioration. Dry heat causes the formation first of soluble starch, and then of dextrin, while moist heat causes the starch granules to swell so that gelatinous starch is formed.

Not only will unleavened bread keep for a long time, but another advantage is that as it is so hard and dry it requires thorough mastication and will when eaten become mixed with large quantities of saliva which aids digestion. This variety of bread is not, however, usually considered very appetizing, and so for general use it has never taken the place of raised bread.

Raising Dough

There are two general methods in use for making dough light—I *Non-fermentation methods;* II. *Fermentation methods.*

I. Bread not Raised by Fermentation

Much time and labor are expended in the making of raised or fermented bread. Not only is the product of the fermentation somewhat uncertain in the hands of the ordinary cook, but some of the nutritive ingredients of the flour are used up in furnishing the materials which raise the dough. In Germany, as well as in America,[1] about fifty years ago, numerous attempts were made to produce good products without employing fermentation. Liebig calculated that in Germany the daily loss of material by the growth of the yeast plant would be sufficient, if saved, to supply 400,000 persons with bread. Baking powders and other chemicals are some of the results of these experiments, that are more or less successful. They are used especially in the preparation of tea biscuit, cakes, pastry and foods of that character. These methods depend on,

(a) Entrapping of air;
(b) Addition of a volatile substance to the dough;
(c) Addition of substances which break up and yield a volatile gas.

(a) Entrapping of Air

1. When Graham flour or fine flour is mixed with water or milk and beaten vigorously for some time, and then quickly baked in cast-iron pans, a fairly light bread results. Sufficient

[1] Bread and Bread Making, Farmers' Bull. No. 389, U. S. Dept. Agri.

air is enclosed in the dough to puff it up, and make it light. The "beaten biscuit" of the South, are made by the use of flour and water or milk, shortening and salt. The dough is beaten, rolled or pounded and frequently folded over until it incloses air blisters, which expand on baking.

2. A modification of this process is used in making pie crust. The lard or other "shortening" is intimately mixed with the flour and water and the dough on being kneaded incloses some air. The dough being somewhat laminated, the particles of flour are isolated the one from the other by the fat, and during baking the air and moisture expand thus making a light flaky dough.

3. This plan may be modified by mixing snow with the flour, and baking quickly. The snow crystals retain considerable air, which expands in the oven and makes the dough somewhat light.

4. Eggs, when beaten to a froth, are well calculated for retaining air, and this mass when mixed with flour has sufficient tenacity so that a large amount of air is mixed with the dough. Sponge cake and angel food cake are made light by the use of eggs alone without any other aerating agent.

(b) Addition of a Volatile Substance to the Flour

5. If an alcoholic liquor, somewhat diluted, is mixed with a flour, when this is baked, the expansion and volatilization of the alcohol at the temperature of the oven, will raise the dough. It is probable that very little alcohol remains in the finished product. Among the objections raised to this method are the expense of the liquor, and the fact that a flavor of the liquor is usually found in the baked material.

6. Aerated bread was invented in 1856 by Dr. Dauglish, an Englishman. It seemed for a time that it would replace other kinds of bread in the United States, but for some reason, probably on account of the lack of the yeast flavor to which we have become accustomed, or because there is no peptonization of the proteins, this bread is not made here at present in any quantity. It is,

however, used extensively in England. This bread is made by stirring together in a strong iron mixer, the flour, salt and water necessary for a batch. The water has been previously impregnated under pressure with carbon dioxide gas, and is in reality the same as the "soda water" of the shops. The carbon dioxide is obtained from the beer vats at the brewery, and compressed. After a thorough mixing with a mechanical stirrer, the dough is forced out of the container, and immediately (since the pressure is removed) begins to rise. After a short time it is placed in the oven and baked by the usual methods. The carbon dioxide, as it is allowed to expand, puffs up the dough, and the baking *sets* the mass in this shape. This was the common method used in London in 1895. Since that time, however, certain modifications[1] in the process have been made. A weak "wort" made by "mashing" malt and flour, is allowed to ferment, until through the agency of bacteria it has become sour. This weak acid liquid is then charged with the carbon dioxide gas, and is found to absorb the gas much more readily, and the acid at the same time softens the gluten. It is said that this process lends itself to the handling of weak or damp flours, from which good wholesome bread is produced, more readily than by fermentation methods.

7. When a somewhat volatile substance like ammonium carbonate in the form of a fine powder or in solution, is mixed with the flour, it will, as it escapes during the process of baking, raise the dough. The decomposition produced by heat is as follows: $(NH_4)_2.NH_2HCO_2CO_3 = 3NH_3 + H_2O + 2CO_2$. Sometimes this salt, in addition to yeast, is added by the baker to make a lighter and consequently larger loaf, or it may be added to overcome the sourness of bread which is produced by overfermentation. The bread is, however, usually dry and tasteless.

8. Sodium bicarbonate ($NaHCO_3$), when heated, gives off a part of its carbon dioxide and some water, and the escaping gas raises the dough. In this process, however, there remains in the product the neutral sodium carbonate, which is an alkaline sub-

[1] The Science and Art of Bread-making, Jago, p. 714.

stance and renders the bread unwholesome. The reaction is $2NaHCO_3 + heat = 2Na_2CO_3 + H_2O + CO_2$.

(c) By the Addition of Substances Which Uniting Chemically in the Dough Set Free Carbon Dioxide Gas

9. When hydrochloric acid is added to sodium bicarbonate in accordance with the reaction ($NaHCO_3 + HCl = NaCl + H_2O + CO_2$), carbon dioxide is set free and sodium chloride or common salt formed. This reaction has been taken advantage of, and is utilized by mixing baking soda with the flour and adding the required quantity of dilute acid to the water used in mixing the batch.[1] Great care is required to use exactly "equivalent" quantities of these chemicals. The flavor of this bread has not proved very satisfactory. The process has been used especially in making whole-meal bread, because that in the presence of so much bran, cerealin is introduced into the dough in such quantity, that, if ordinary fermentation processes are used, diastasis will proceed to a serious extent, and the bread will be soft and clammy. Jago,[2] in discussing this kind of bread says: It is to be deplored that for the sake of getting the nutriment *supposed* to be in the bran, a section of the public should demand a form of bread so unhealthy in other respects."

10. By the use of baking soda and molasses, it is possible to obtain an excellent product, if care is exercised in using the right proportions. The molasses contains some free acid or acid salts which act upon the baking soda and set free the carbon dioxide, leaving a neutral salt of the acid in the product. Gingerbread is made by this process. In case the molasses is not sufficiently acid, a little vinegar may be added to it before mixing.

11. A light and wholesome product may be obtained by the use of baking soda and freshly curdled sour milk. In this case there is left in the bread, sodium lactate, a harmless salt, and carbon dioxide is set free as in the other cases. One teacup of

[1] The Science and Art of Bread-making, Jago, p. 401.
[2] Ib., p. 402.

sour milk will usually neutralize a teaspoonful of baking soda. Here again a little vinegar may be used to render the milk more acid, but it is better to use less soda in neutralizing. Cakes and biscuit are not only raised by this process, but they are made richer and more nutritious by the fat and the casein of the milk. An excess of baking soda, renders the product yellow and unwholesome. The chemical equation representing the process is:

$$NaHCO_3 + \underset{\text{Lactic acid.}}{C_2H_5O.COOH} = \underset{\text{Sodium lactate.}}{C_2H_5O.COONa} + H_2O + CO_2.$$

12. Among the most useful reagents selected for the raising of dough without fermentation, are sodium bicarbonate and cream of tartar. Substitutes for the latter are alum and calcium phosphate. In the case of cream of tartar, this and the soda should be mixed with the flour before it is moistened. The porportions of each substance to be used are calculated from the molar weights and are very nearly one part of soda to two parts of cream of tartar. The equation representing what takes place in the dough is as follows:

$$\underset{\text{Cream of tartar.}}{KHC_4H_4O_6} + NaHCO_3 = \underset{\text{Rochelle salts.}}{KNaC_4H_4O_6} + CO_2 + H_2O.$$

13. *Baking Powders.*—Baking powders are prepared with the object of utilizing the compounds mentioned in the last paragraph (12) in a convenient and practical way. The "alkaline" or gas-forming" ingredient in all of them, is sodium bicarbonate, and the "acid" substance is either cream of tartar (sodium bitartrate), calcium phosphate, phosphoric acid, or alum, with the addition of not over 30 per cent. of starch or in some countries rice flour as a "filler." The starch would not, unless in excess, be regarded as an adulterant, as it is used to prevent the chemicals from combining during the storage of the powder. While the chemical change cannot take place when all the materials used are *perfectly dry*, when they are moistened, as in the making of bread or cake, the chemicals react, and carbon dioxide gas is set free. Baking powders

are sometimes found on the market without any "filler," but they are not well adapted to keeping for any length of time.

A good baking powder can be made by mixing 2 pounds of baking soda, with 4 pounds of cream of tartar, and a little less than 2 pounds of starch. Mix the soda and the starch first, then after adding the cream of tartar, mix very thoroughly. It is absolutely essential that the ingredients be *perfectly dry*. In cream of tartar baking powders, some of the cream of tartar is often replaced by tartaric acid, but when this is done the chemical reaction takes place more rapidly, and therefore may go too far before the dough is placed in the oven.

In the case of the phosphate powders, the residue remaining in the bread consists of acid calcium phosphate ($CaHPO_4$) and acid sodium phosphate (Na_2HPO_4). When alum is the "acid" chemical used, there remains in the bread sodium sulfate (Na_2SO_4) potassium sulfate (K_2SO_4) or ammonium sulfate ($(NH_4)_2SO_4$) and aluminum hydroxide ($Al(OH)_3$). Instead of a soda or ammonia alum frequently "burnt alum," aluminum sulfate, or what is known in the trade as "C. T. S." (the calcined double sulfate of sodium and aluminum) is used. It is considered by many manufacturers advantageous to use a mixture of alum and acid calcium phosphate. An acid sodium sulfate ($NaHSO_4$) with sodium bicarbonate is also used for making baking powders. Quite recently small quantities of albumin have been introduced into some brands of baking powder. Although such a powder would appear to produce more foam when dissolved in water there seems to be no good reason for supposing that the leavening quality of the product is improved.

Wholesomeness of Baking Powders

Much controversy, stimulated often by rival manufacturers, has arisen in regard to the wholesomeness of the residue remaining in bread made with different kinds of baking powder. Rochelle salt, left in the product by the use of cream of tartar baking powders, has somewhat of a laxative effect. A loaf of bread would contain even more of this salt than is found in a Seidlitz powder,[1] but the amount present in the bread consumed at a single meal is so small that its effect on the system can be practically disregarded. In the case of the phosphate powders the sodium phosphate left, acts as a mild purgative in doses of from 1 to 2 ounces which is, however, much more than would be found in the bread used at one time.

More objection has been raised to alum powders than to the others, on the ground that the aluminum hydrate left in the bread has not been heated, except on the exterior of the loaf, to a high enough temperature to render it insoluble in the slightly acid gastric juice. It is a well-known fact that this salt as well as alum, has an astringent action on the system. With the common tendency to constipation, especially among those of sedentary occupations, it would be well to guard against aggravating this tendency by the use of any astringent food. As ammonia salts have an irritating effect on the animal tissue, the use of ammonia alum is considered the most objectionable.

Valuation of Baking Powders

The value of a baking powder is proportional to the amount of "available" carbon dioxide gas set free when the powder is moistened. This is from 8 to 15 per cent. of the weight.[2] Old baking powders, or those which have not been well dried, or which have not been well enough packed to exclude moisture, are usually so deteriorated as to be of little or no value. In some States, in order to insure to the consumer a good quality of a baking powder, the date of manufacture is required to be printed on the label. Another plan, and perhaps a better one, which has been adopted in the standards of some States is to require that all baking powders yield a certain per cent. of available carbon dioxide gas. The average amount of carbon dioxide which baking powders yield is

[1] Human Foods and Their Nutritive Value, Snyder, pp. 186–192.
[2] Bull No. 13, Pt. 5, U. S. Dept. Agri. Div. Chem.

60 cubic inches per ounce.[1] It has been found that a standard requirement of not less than 10 per cent. of available carbon dioxide is fair and will protect the consumer against goods which have been in stock for a long time and so are practically of no value. In any requirement of not less than 10 per cent. of available carbon dioxide is fair and will protect the consumer against goods which have been in stock for a long time and so are practically of no value. In any case the composition of the powder should be printed on the label. The amount of baking powder used in the United States is much larger than in other countries.

II. Bread Raised by Fermentation

In raising bread by the process of fermentation, there are three methods:

1. *By the use of leaven.*
2. *By the "salt-rising" process.*
3. *By the use of yeast.*

1. It was found a long time ago that if some of the dough from one baking be set aside, it could be used as a "starter" for the succeeding batch. Care should be taken that the dough is not kept in too warm a place, lest a disagreeable taste be communicated to the bread by excessive souring. As the yeast cells already exist in the air, and will readily grow when they fall into a proper medium, it is possible to raise bread without the addition of yeast. If, however, we depend upon getting the yeast from the air, other organisms are liable to be mixed with the yeasts, and they will produce acids such as acetic and lactic, and the dough will be sour. This sour, fermenting dough was no doubt the first used and was perhaps the original "leaven." Since the introduction of bakers and brewers yeast and dry and moist yeast cakes, this process has been little used. It finds favor chiefly for raising bread made from rye and other coarser bread stuffs and is known as the "Sauerteig"

[1] Mallet, Chem. News, 1888, II, 276.

method. The black, sour "Pumpernickel" and the "Schwartzbrod" used in certain parts of Germany, are made in this way.

2. The salt-rising process utilizes the fact that there exist in corn meal, flour, milk and other ingredients used in making bread, certain bacteria which can be encouraged to grow and multiply above a fixed temperature, which temperature effectually kills most other organisms. It has been recently shown by H. A. Kohman,[1] that true gas-forming bacteria will grow under the conditions prevalent in making salt-rising bread, and the gas produced is about two-thirds hydrogen and one-third carbon dioxide. He has also found it practicable under the right conditions of temperature, and in a suitable medium, to isolate these bacteria. This special variety can be dried and put upon the market as a "starter" for making salt-rising bread. This method has the advantage of insuring always a satisfactory bread, and not depending on "luck" as is so often done.

Salt-rising bread is made as follows:

Salt, corn meal and baking soda are mixed together. The milk is brought to the temperature of boiling and the other ingredients are stirred into it. This mass is allowed to stand from twelve to fifteen hours or over night and is then mixed with flour and water in the right proportions, just as a "sponge" is mixed in the making of ordinary bread, and the dough is allowed to stand for some time at a temperature of 100° F. The bacteria will not be injured by a high temperature even up to 200° F., while the yeasts and molds are killed at these higher temperatures. When the dough has risen sufficiently it is molded into loaves and baked as usual.

The chief source of the bacteria is not the air or the utensils used in the process, as was formerly supposed, but the corn meal. Bread made by the "leaven" process differs from that made by the "salt-rising" process, in that the former owes its leavening power mainly to yeasts, while in the salt-rising process it is due to gas-forming bacteria. The loss of materials, due to the decomposition

[1] Botanische Zeitung, 47–405, 420, 435; Baker's Helper, Sept., 1909, p. 1023; also, J. Ind. and Eng., Ch. Vol. 4, 1912.

and volatilization of some of the constituents of the flour is much less in salt-rising bread than in that raised by yeast. The former variety has a fine grained texture and frequently an odor that is by some considered disagreeable.

3. In making bread with yeast in the United States, there are three general processes used: first, the sponge, and dough method; second, the ferment and dough method; third, the straight dough process.

In the sponge and dough method, the sponge consists of a slack dough composed of flour, water and yeast, these being mixed in the evening and allowed to stand till the next morning when water is added, the dough is brought to the proper consistency with flour, kneaded and finally put into the pans. The advantage of this method is that the sponge is prepared in the evening, and worked the next morning, and also only about one-third as much yeast is required as in the straight dough method.

In the ferment and dough method, a potato ferment is frequently used by small bakers and housewives. This is prepared by cooking potatoes, cooling, mixing with yeast and flour and allowing the mass to ferment. It is then added to flour and water, made into a dough of proper consistency and handled as in the sponge and dough method.

In the straight dough process, which is most extensively used in all large bakeries, the materials, flour, water or milk (sugar), lard, and yeast are all mixed at the same temperature. Considerable yeast, even as much as 1 per cent. is used. Only one mixing is required in this process, and not so much handling. The flour is first sifted and blended by running through silk bolting cloths. This process has the added advantage of breaking up the particles of flour which have become closely impacted together and at the same time two or three flours of different types may be blended. For instance, Minnesota flour which is lighter in color is mixed with a Kansas or Illinois flour, which is stronger in gluten. After the blending process, which is usually carried on in the lower story of the bakery, the flour is elevated to the mixers. These are so arranged that the solid materials can be weighed upon a scale, often automatically controlled, and the amount of water used can be similarly measured. The salt used is first dissolved in a small quantity of water. The lard or shortening is added after the mixers have made a few turns, because if the lard comes into direct

FIG. 11.—Bread mixer. American Oven and Machine Co., Chicago.

contact with the flour, at first it interferes somewhat with the absorption of water. The "mixer," which is a power-driven machine (Fig. 11), is usually run from twenty to thirty minutes at a rate of about thirty to sixty revolutions a minute, causing a very thorough mixing of all the ingredients. One thousand pounds of dough can be handled at one time. (Fig. 12.)

After it is mixed, the dough is put into troughs in the fermentation room and allowed to stand. The temperature of this room, which is commonly about 80° F., is so regulated that it never varies more than one or two degrees. In the summer refrigeration keeps the temperature down, and in the winter the room is warmed. It is very important to regulate the temperature of the dough before it goes into the fermentation room, as such a large mass of dough will hold its temperature for five or six hours.

In recent years the period of fermentation has been much reduced so that instead of requiring ten hours as formerly, six

FIG. 12.—Bread mixing room equipped with automatic scales for flour and water as seen above mixers. Brunner B aking Co., Buffalo, N. Y.

hours are sufficient. In order to do this more yeast, and that of a stronger variety is employed. During fermentation the dough is worked by hand three times, allowing the gas to escape and bringing the yeast in better contact with the dough. The carbon dioxide gas which is given off, if allowed to remain in the dough checks the fermentive power of the yeast.

The dough is next "scaled" off into loaves of the required size by a machine especially designed for this purpose, so as to secure uniform weight for the loaves. After "scaling" it goes through the process called "rounding," after which the bread is allowed to stand for about fifteen minutes to rise. The dough is then put into the molding machine and molded into the desired loaf. These loaves are again allowed to rise in the pans and this process is hastened by keeping the temperature as high as 100° F. in steam boxes. The steam at the same time moistens the top of the loaf and prevents its drying out. Some of the materials used by modern bakers are, powdered milk, which has the advantage of keeping indefinitely; compressed yeast; cotton-seed oil; malt extract, which is sweet and communicates a characteristic flavor to the bread, and which contains diastase, a substance which greatly assists the process of fermentation.

A common proportion of ingredients used in making bread is as follows: 100 pounds of flour, 58 to 62 pounds of water, 1 pound of yeast, 1 1/2 pounds of salt, 1 1/2 pounds of shortening, 2 pounds of sugar, and 1 pound of milk powder or its equivalent in condensed milk.

Baking

In the process of baking the ovens are heated from beneath. (Fig. 13.) The fire is drawn down previous to putting in the bread, as the heat is more uniform if it comes from the heated brick chamber alone. This heat retained by the brick is sufficient to bake bread for four or five hours. In the commercial or "peel" oven the temperature is higher than in domestic practice, being from 450° to 500° F., while smaller goods are often baked at a temperature of 600° F. The ordinary loaves bake in from thirty to forty minutes. The temperature attained by the *interior* of the product when done is 212° F.

In the old-fashioned "brick ovens" which were in common use in the United States until the introduction of stoves about 1850, and which are still in use in many foreign countries, and even dy large baking establishments, the fire is built in the oven, anb when the fire brick of the floor and the arch has become thoroughly heated, it is withdrawn, and the ashes removed. Bread and pastry may then be baked in this oven for several hours before the heat is exhausted. The process has the advantage of giving a uniform heat, and when the oven becomes too cold, a little additional fire will soon raise the temperature sufficiently for baking.

The "baking effect," is due to the radiation from the walls, more than the temperature of the oven. On this account the character of the walls deserve special study. They should be black to secure the maximum radiating effect.

FIG. 13.—Peel oven, Brunner Baking Co., Buffalo, N. Y.

Yeast and its Action

The yeast plant requires certain definite conditions of temperature nutrition and moisture for its growth. It is a monocellular organism which grows or multiplies by a process of budding, and feeds upon sugar and similar materials in saccharine or starchy substances. It also requires and uses in its growth nitrogenous and certain mineral constituents especially potash and phosphoric acid.

Yeast is classified as one of the saccaromyces, *Torula cerevisiæ*, and possibly indirectly brings about the change of starch to sugar, thus: $C_6H_{10}O_5+H_2O=C_6H_{12}O_6$; and the change of sugar to carbon dioxide and alcohol, thus: $C_6H_{12}O_6=2C_6H_5OH+2CO_2$.

It is most active between 70° F. and 90° F., and is destroyed if the temperature is raised to 131° F. If the yeast plant does not grow vigorously in the medium a sour and unpalatable bread will result, as other substances, especially those having acid properties may be produced. In the use of potatoes for making the sponge the baker has learned to use a medium which is rich in peptone, tyrosin, asparagin and other protein bodies, which are powerful stimuli of enzymic action. Rye flour added in small quantities to wheat flour, assists fermentation, perhaps because it contains a greater proportion of soluble proteins. Malt extract, cane sugar and milk all assist in the fermentation, and improve the flavor of bread.

Both baker's and brewer's yeasts are made commercially in large quantities. In some establishments great care is exercised to obtain yeast of the very best quality, and the desirable varieties, frequently imported from Germany, are isolated from others, and propagated.

Compressed yeast, which is often a product of the distilleries has come into general use in domestic practice in the United States. The yeast settling out of the "wort" is purified, and pressed into cakes and wrapped in tin foil. It is a "present use" yeast and should be kept in the refrigerator if not used as soon as purchased. It is held that if starch is added to compressed yeast, that fact must be stated on the label.[1] The dried cakes on the market are sometimes made by mixing yeast with starch or corn meal, making into cakes, and drying at a moderate temperature. Although this yeast acts slowly, it will keep for a long time in a dry place. It is said that yeast cakes were used by the Romans in the first century.[2]

Chemical Changes Produced

It is of interest to note what changes besides the production of carbon dioxide gas and alcohol actually take place in the making of

[1] U. S. F. I. D. No. 111.
[2] Tibbles, p. 403.

bread. The gluten already referred to as a constituent of wheat flour (p. 64) is composed of the two substances gliadin and glutenin. Gliadin is the substance which binds the flour particles together to form the dough, and gives it tenacity and adhesiveness, while glutenin is the material to which the gliadin adheres.[1] These two substances must be present in the flour in the right proportions if the flour is to have the highest bread-making properties. Wheat flour contains only small amounts of albumin and globulins, and these are rendered insoluble by the action of heat in baking.

The proportion of protein is, however, but little altered in the process of bread-making, although some of the soluble proteins have been used up by the yeast. The slight losses of both nitrogen and carbon compounds that may take place during the process are more than offset by the increased solubility and digestibility of the proteins and carbohydrates in the finished product.[2]

The fat contained in the flour is slightly oxidized and changed in color in bread-making, similar to the process called "aging" which takes place in flour during long storage.

During the alcoholic fermentation, about 1 per cent. of carbon dioxide and an equal weight of alcohol are produced, and volatilized in baking. The soluble carbohydrates are those which are acted upon by the alcoholic ferments. The yeast plant also secretes soluble ferments which act upon the starch to form soluble carbohydrates. About 10 per cent. of the starch is changed to the soluble forms known as dextrin-, dextrose-, and sucrose-sugars. The brown coating or dextrin on the surface of the loaf of bread, is produced mainly by the action of heat upon the starch. Although dextrin still has the composition represented by the symbol $(C_6H_{10}O_5)_n$ it has different physical properties from starch and is more readily digested.

By way of comparison the following table given by Snyder[3] shows the composition of flour, and bread made from it in different ways.

[1] Human Foods, Snyder, p. 169.
[2] Loc. cit.
[3] Loc. cit.

Material	Water, per cent.	Protein, per cent.	Fat, per cent.	Carbo-hydrates, per cent.	Ash, per cent.
Flour	10.11	12.47	0.86	76.09	0.47
Bread from flour and water	36.12	9.46	0.40	53.70	0.32
Bread from flour, water and lard	37.70	9.27	1.02	51.70	0.31
Bread from flour and skimmed milk	36.02	10.57	0.48	52.63	0.30

Effect of Keeping on the Composition of Bread

The difference between the digestibility of new and stale bread is largely due to the physical condition of the material. Although the amount of soluble dextrins diminishes with age it is not enough to materially interfere with the digestibility. New bread is difficult to masticate on account of its softness and its tendency to collect in heavy masses into which the digestive fluids penetrate with difficulty. A stale bread, on the other hand, maintains its porosity during mastication.

Bread when kept for a time loses some water, but this is not enough to account for the difference in its quality as compared with fresh bread. Stale bread can be partly freshened by reheating, but in this process it loses still more water. There are various theories in regard to the difference between fresh and stale bread. Bibra maintains that fresh bread contains free water some of which unites with the starch and gluten as the bread becomes stale. M. Lindet[1] has shown that as the bread becomes stale a part of the starch which was transformed into amylodextrin, returns at the end of twelve to twenty-four hours to the state of starch. By reheating it is claimed that some of the amylodextrin reappears, and thus the bread again has the characteristics of fresh bread. Williams[2] believes that when the bread becomes stale the fibers shrink and the cell walls become more compact or

[1] Bull. Soc. Chim. d. Paris, XXVII.
[2] Chemistry of Cooking.

solid, and that reheating causes the moisture to be given off and the cell walls to expand so that the bread appears to be more porous.

Toast

When bread is toasted, some of the starch changes to dextrin which is more soluble than starch and also more digestible, but the proteins are rendered less soluble, and hence slightly less digestible.[1] Toasting causes the bread to yield more readily to the action of diastase and other ferments, and at the same time tends to sterilize the bread and kill those ferments that were not destroyed in the process of baking.

In order to obtain the best results from the use of toast it should be toasted so that it is crisp throughout. This is attained in the "rusk" which is put on the market by the large bakers, and in the "zwiebach" of the Germans. Both these products are valuable food, especially for dyspeptics, as they furnish abundant nutriment which is easily available, and complete mastication is necessary.

Some Causes for Bad Bread

Bread, although it has been subjected to the heat of the oven is by no means sterile. It presents an excellent medium for the growth of various molds and bacteria, the germs of which were in the flour or other materials used. The sourness of bread is due to the development of lactic, butyric and acetic acids, whenever the conditions become favorable for the growth of the ferments which produce them. If the fermentation is carried too far in an effort to get a large loaf of bread out of a small amount of flour, or if the temperature of fermentation is too high these acid-forming organisms get the upper hand, and sour bread results. The best bakers sacrifice a little *bulk* for *quality*, and produce a non-acid bread with a sweet agreeable, nutty flavor, a product which is both wholesome and palatable.

[1] Minn. Ex. Sta. Bull. No. 47.

"*Ropy bread*" is due to the growth of spores of an organism, which is found especially in potatoes. The heat of the oven does not destroy these spores in the interior of the loaf, so that in moist, warm weather they develop there and cause the crumb to become moist, and sticky, and have a disagreeable taste and odor. Molds of various colors grow on bread as it increases in age. One of these (Pencillium glaucum), the bluish-green mold, is active in the ripening of certain cheeses, as the English "Stilton," and the Italian Gorgonzola. (See pp. 419, 422.)

Varieties of Bread

In addition to white bread many other kinds are used in different countries, and prepared commercially: "Graham" bread (see p. 30) and entire "wheat" bread are shown by chemical analysis to contain more protein than that made from the patent flours.[1] According to digestion experiments, however, the proportions of digestible or available protein and available energy in the patent flour are larger than in either the entire wheat or the Graham flour. The lower digestibility of the protein is due to the fact that in the coarse flours, a considerable portion of the protein is covered up inside the bran particles, and so resists the action of the digestive juices. The advantage of the use of these coarse breads due to their stimulating the activity of the bowels, should not be forgotten.

Vienna rolls which have a crisp exterior, and a large amount of dextrin, are a common food on the Continent of Europe, and to some extent in other countries. They are made from a high grade of flour with a large proportion of yeast. They are baked in an atmosphere of steam under pressure, and thus the water on the surface of the rolls gelatinizes the starch and gives a glazed appearance to the rolls. This is sometimes imitated by brushing the surface of the rolls with egg albumen before baking.

Other forms of bread are rolls, which are raised with yeast, and

[1] U. S. Dept. Agri. Exp. Sta. Bull. No. 101.

contain sugar, and "shortening"; milk rolls which are mixed with milk instead of water; muffins, made by the use of baking powder, and lard, and rapidly baked in an iron pan; Scotch scones, made like pancakes and baked on a hot plate. German pretzels are made from a dough raised with yeast, and just before baking the strips are plunged into boiling water in which oat straw is soaked. After salting heavily the pretzels are baked quickly, and then allowed to cool slowly in a warm oven.

Adulteration of Bread

On account of the importance of bread as the "Staff of Life," civil authorities have in all countries kept a sharp watch for adulterations. As flour has gone higher in price, or as the cupidity of the bakers has increased, there has been a tendency to diminish the weight of the loaf which was sold for 2 1/2 d. 20 centimes, 25 pfennigs, or 5 or 10 cents. This has led in most countries to a regulation regarding the weight of the loaf, or the price per pound or has called for regulations requiring all loaves that did not weigh a pound or 2 pounds to be plainly marked with the weight.

In England bakers have attempted to fradulently increase their profits by making bread which contains as high as 40 per cent. of water 5 per cent. more than normal bread. This may be effected by putting the bread at first into a very hot oven so as to cover the surface with a glaze which tends to keep an extra amount of water under.the crust. Copper sulfate, in doses of 1 gram to 35 kilograms of flour has been used in bread to enable the baker to add more water and to whiten the loaf. Alum and borax have also been used, for the purpose of whitening the loaf. The use of flour other than wheat is an adulteration, unless the bread is sold with a proper label stating its composition.

Food Value of Bread

Different kinds of bread have a different food value as shown by the following table:[1]

[1] U. S. Dept. Agri. Farmers' Bull. No. 142.

White bread has a fuel value of	1200 calories per pound
Brown bread has a fuel value of	1040 calories per pound
Graham bread has a fuel value of	1195 calories per pound
Whole wheat bread has a fuel value of	1130 calories per pound
Rye bread has a fuel value of	1170 calories per pound
Crackers	
Cream crackers have a fuel value of	1925 calories per pound
Soda crackers have a fuel value of	1875 calories per pound

The fuel value corresponds quite closely to the food value, except that, as previously stated, some foods are more completely digested than others.

Experiments made both on men and on dogs by Mendel and Fine[1] indicate that "'glidin' gluten and the two characteristic proteins of wheat gliadin and glutenin are as thoroughly utilized as the nitrogenous components of fresh meat."

Foods Complementary to Bread

As bread, for a perfect food, is somewhat deficient in protein, it is commonly supplemented by the use of meat, cheese or some legumes such as beans. As it is deficient in fats, we use butter or "gravy" to supply this need. Since there is not sufficient lime in the wheat products, they are often supplemented by the use of milk. Bread and milk, especially if "whole milk" is used, has long been considered an excellent food, especially for children.

MACARONI

Macaroni, which is made from hard wheat, is a preparation of a glutinous character, the manufacture of which is made possible by the presence of a large amount of gluten in wheat flour. It is drawn, molded or stamped into various forms, known in the trade as macaroni, vermicelli, spaghetti, noodles, Italian paste and similar products. The largest quantity of macaroni wheat is raised in southeastern Russia, from which country at least 25,000,000 bushels are annually shipped to Italy and France for the manufacture of macaroni. Durum wheat, which has previously been referred to, is well adapted for making macaroni. It grows well in semi-arid regions, where the conditions are great

[1] J. Bio. Chem., Vol. 10, p. 324.

extremes of temperature with a small rainfall, but so distributed that a good proportion of it falls during the growing season.

Material Used

For the manufacture of macaroni[1] in many localities the granular flour specially prepared for this purpose, and known to the Italians as "semolina" or "smola" is used. The wheat, which must be first thoroughly cleaned and washed, after drying is again moistened before grinding so that the bran obtained may not become mixed with the flour. The ground product is then passed through sieves of different degrees of fineness. From this process there results about 65 per cent. of semolina, the coarsely ground product, and 17 per cent. of flour.

Semolina is a favorite food in some localities of France and England. The millstones in which it is ground, are grooved so that the product is obtained in a granular condition instead of a powder. The granules which remain after sifting out the finer flour are of a yellow color and rich in gluten. It is especially useful for making puddings and porridge.

Process of Making

The making of macaroni is but an extension of the method so long in use by the housewife in making "noodles." For this purpose dough is rolled out in thin sheets and these are cut into strips, which are either used directly in soups or first hung up to dry. A yellow dye is sometimes added to noodles to simulate the presence of eggs.

For the manufacture of macaroni on the large scale, the semolina with a measured quantity of water is put into a steel pan about 8 feet in diameter. The amount of water must be very carefully regulated with regard to the quality of the semolina, and to the product desired. Within the pan travels a stone wheel, and as it is made to move slowly around the pan, the dough is thoroughly mixed. This operation requires at least thirty-five minutes.

[1] Manufacture of Semolina and Macaroni, R. P. Skinner, U. S. Dept. Agri. Bur. Pl. Ind. No. 20.

The dough is then passed into a perpendicular hydraulic steel press, the bottom of which consists of a bronze die perforated with holes, and in the center of each hole is a pin attached to one side. This pin forms the hole in the macaroni, and although it divides the

FIG. 14.—Drying macaroni in Italy.

dough as it enters the hole, it comes together as a perfect tube when it leaves the bottom of the die. (For making spaghetti the die contains plain holes about 1/8 of an inch in diameter, so sticks or rods are formed.) A piston forces the dough into strings or tubes which are afterward cut into pieces about 3 feet long, hung on racks, in the sun, for two hours, and cured at a temperature of 70° F. (Fig. 14.) After this preliminary drying the product is stored for twelve hours in a cellar to allow the moisture to become better distributed, and then again dried for several days in the open air, or more quickly in a current of air in a properly constructed chamber.

The name **"vermicelli"** is applied to the smaller rods. A great variety of Italian "pastes" as they are called, are put upon the market. The genuine macaroni is translucent in appearance and is so tough that it will resist considerable rough handling without breaking.

Food Value

During cooking macaroni swells up and absorbs as much as three times its weight of water. Foods of this class are almost entirely absorbed in the alimentary canal, and when served with cheese so as to increase their protein and fat content, form a well-balanced ration. Comparing the composition of macaroni, either foreign or domestic, with that of wheat, it is seen that there is no great difference between them:

	Typical wheat	Genuine macaroni	Italian macaroni from Kans. hard wheat
Moisture	10.60	10.05	10.36
Protein	12.25	13.06	12.06
Fat	1.75	0.24	0.38
Ash	1.75	0.65	0.51
Carbohydrates, by difference	73.65	75.50	76.12
Crude fiber		0.50	0.57

The amount of macaroni, vermicelli and similar products used in the United States is constantly increasing; this is partly on account of their use by the immigrants who come from southern Europe, and to quite a large extent because a taste for this food is being cultivated here. No less than 105,926,968 pounds of these products were imported in 1912.[1]

BREAKFAST FOODS; PROPRIETARY FOODS

Within the past twenty years there has arisen a demand for specially prepared food, which offers a concentrated form of nourishment and which may be readily prepared for the "hurry up" American breakfast. The number of these is legion, and their beneficial properties have been heralded in the advertising pages of newspapers and magazines and on the bill boards.

[1] Bull. Dept. Commerce and Labor.

The breakfast foods are made mostly from wheat, corn, oats, barley and rice with an occasional addition from other sources, and their food value is often grossly misstated by the manufacturers. These foods may be divided into the three classes:

1. *Raw cereals* prepared by crushing the grains to different degrees of fineness after decorticating.

2. *Partially cooked* preparations from these grains.

3. *Malted cereals*, in which the moist grains are ground and mixed with malted barley, so that a portion of the starch is converted into maltose and dextrose, after which the mixture is crushed between hot rollers and dried.

Composition

The following selected analysis may be considered:

Name	Moisture	Protein	Total carbohydrates	Crude fiber	Fat	Ash
Pettijohns breakfast food[1]	9.51	10.56	76.96	2.01	1.45	1.52
Ralston[1]	9.72	15.10	71.75	1.55	1.90	1.53
Cracked wheat[1]	9.30	12.60	74.42	1.49	2.22	1.46
Quaker oats[1]	7.40	17.20	66.65	1.40	6.08	1.67
Bulk oats[1]	8.07	17.74	65.89	0.99	6.52	1.78
Cerealine (from corn)[1]	9.55	9.90	78.75	0.72	1.24	0.56
Cream of wheat[2]	10.69	11.75	76.17		0.95	0.64
Vitos (Pillsbury's)[2]	8.74	12.69	76.56		0.98	1.03
Wheatena[2]	8.41	11.50	75.23	1.03	2.10	1.73
Zwieback[1]	10.64	14.31	68.87	4.21	0.49	1.48
Grape nuts[1]	8.00	12.73	73.78	2.02	1.57	1.90
Toasted corn flakes[1]	9.63	9.21	78.31	0.57	0.54	1.74
Shredded wheat[2]	9.45	11.06	76.41		1.42	1.66
Puffed wheat berries[2]	10.19	13.06	73.72		1.63	1.61
Holland rusk[2]	7.59	12.44	72.87	0.32	5.88	0.90
Egg-O-See[2]	8.24	10.87	76.15	1.36	1.18	2.12
Grape sugar flakes[3]	8.13	10.27	75.87	2.28	1.76	1.69
Tryabita food[3]	9.69	11.81	72.47	2.57	1.08	2.77

[1] Wyoming Ex. Sta. Bull. No. 33.

[2] Penn. Dept. Agri. D. and F. Div. Bull. No. 162.

[3] Mich. St. Agri. Co. Ex. Sta. Bull. No. 211.

Discussion

An examination of these analyses shows that these products do not vary so much in composition as the claims of the manufacturers would lead us to expect. The oat products are, as would be expected, high in protein and fat. The products which are made from wheat, although sold under different names, are quite similar in composition. The "flake" breakfast foods of different manufacturers are similar in composition.

As a result of digestive experiments with some of these malted products,[1] although the converting action of the malt had changed a fair percentage of the starch to reducing sugar, yet the nutritive material contained is about as digestible as that of rolled wheat, although the process has at the same time rendered the protein less digestible. A far larger proportion of the starch in these malted products remains unchanged, than that which is converted by the action of the malt. The analyses show that the statement, that the starch is eliminated in the process of preparation and therefore the breakfast food is especially valuable for the use of dyspeptics, is untrue. After all is said a product made from wheat or corn or oats will not be very superior to its source in nutritive value.

It is urged in defense of the use of prepared breakfast foods sold in packages that they are less liable to accumulate dust and dirt, than those sold in bulk. This is in general true, and this method of sale is an advantage especially when "individual" packages are served on the table; but there is an opportunity for the grocer to store unsold packages, for a long time and these are sometimes found to be infested with worms and insects, and to be absolutely unfit for use.

While these foods contain considerable crude fiber which diminishes their nutritive value, this may on the other hand render them more wholesome to the average person. There is also a question whether a partially digested food, is really desirable for the person with normal digestion.

[1] Maine Agri. Exp. Sta. Bull. No. 118.

On account of the almost universal use in the United States, of these "easy to prepare" foods, among all clases, the question of economy should not be overlooked. By actual weight the following is the retail price *per pound*, at which some of these foods have been selling. Quaker oats, 7.3 cents; Nichol's pearl hominy, 5.3 cents; cream of wheat, 8.8; grape nuts, 17.1; shredded whole wheat, 20; force, 16.5; flaked rice, 18.2; granula, 27.2; Quaker corn flakes, 13.3; Kellog's corn flakes, 20; maple corn flakes, 14.5; post toasties 18.4; grape sugar flakes, 17.8; malta vita 18.4; sugar corn flakes, 20; Holland rusk, 22.8; puffed wheat, 27. At these rates a bushel of wheat, costing originally $1.00, would when made into breakfast cereals cost from $5.00 to $12.00. These prices indicate that the consumer is paying *luxury prices*, for ordinary nutritive foods.

PANCAKE FLOUR (Self-raising flour)

In order to still further decrease the labors of the household, a large variety of self-raising flours have been placed on the market. These are, of course, only flour mixed with salt and baking powder. The analysis of a few typical brands is sufficient for comparison.[1]

Name	Moisture	Protein	Starch, fiber ash, leaven	Fat	Total carbon dioxide[2]
H-O pancake flour	9.27	8.21	81.10	0.82	0.65
Aunt Jemina's pancake flour	9.15	9.87	80.29	0.69	0.41
Hecker's self-raising buckwheat	10.32	8.69	80.39	0.60	0.45

There is here an opportunity for adulteration by the substitution of some cheaper flour for buckwheat flour, or corn flour for wheat, so the label should be carefully inspected.

[1] Pa. Dept. Agri. Dairy and Food Div. Bull. No. 162.

[2] Phosphate baking powder used.

PROPRIETARY FOODS

The proprietary foods and those designed for infants and invalids are used because of certain constituents which they contain that are needed to nourish the system under abnormal conditions. These foods are either farinaceous, prepared from cereals, either cooked or malted, or from mixtures of cereals with milk products. The common fault of these foods is that they contain too much sugar and starch and not enough fat. The starchy baby-foods should never be given to a child under eight or nine months of age, as the secretions in the earlier months are entirely unfitted to digest such foods.[1]

Some of these, are made up of baked dry wheat flour, sometimes mixed with the flour of barley or oats. The more soluble starch foods[2] are made by mixing ground wheat and barley malt with water to form a paste to which a little potassium bicarbonate is added. This mixture is heated at 65° C. for a sufficient time to convert the starch by the action of the malt diastase; the mixture is extracted with warm water, and this solution evaporated to dryness. This contains such sugars as maltose and dextrin.

In the preparation of the milk foods, whole or skimmed milk is evaporated to dryness and mixed with sugar or baked cereal flours. Desiccated milk mixed with a dried extract of malted cereals is also used.

Tibbles[3] has collected a very complete list of analyses of foods of this class. He says: Horlich's malted milk consists of desiccated milk 50; wheat flour 26; malt 23; soda bicarbonates 0.75 parts. Carnick's soluble food consists of dried milk 37.5; malted wheat 37.5; milk sugar 25 parts. Nestle's food consists of equal parts of dried milk, baked flour, and cane sugar, therefore much starch remains unchanged. Mellin's food is made of wheat flour, malt and carbonate of potash; it is digested by Liebig's process

[1] Practical Dietetics, Thompson, p. 147, 759.
[2] Food Inspection and Analysis, Leach.
[3] Loc. cit.

until all the starch is converted into dextrose and dextrin; it is then strained to remove cellulose, husks, bran, etc., and evaporated to dryness in a vacuum pan at 140° F. Ridge's, Neave's and Frame foods are baked flour in which some of the starch is dextrinized by heat.

These foods are often compared in composition to human milk, and it will be seen that they usually show too much starch and sugar. The patent foods in which the starch is unconverted, possess no advantages as additions to the diet of older children over such simple articles as oatmeal, rusks, and rice, and the latter are much cheaper.[1]

Non-scientific Diet Systems

A recent report[2] of the U. S. Department of Agriculture in regard to statements about many systems of diet recommended for commercial profit, seems pertinent, in this connection. "Some of the advocates of freak diets are sincere, but are themselves deluded, while others are fakers who seek to make monetary gain, by advising peculiar systems of diet." One of these fads is the use of *raw food*. While there is no objection to the use of raw food by a person if he likes it, and can prove that it agrees with him, yet as a general proposition man will stand a better chance to thrive if he uses *both* cooked and uncooked foods, in the ways that they have proved to be satisfactory after thousands of years of experience by the human race. Although raw food may be thoroughly washed, yet much of it is not as fit for food as when cooked, because in the latter process it is thoroughly *sterilized*. Another argument used for raw foods is the necessity for enzymes in food, but with the ordinary mixed diet containing fruit and raw milk, no such special diet is required. Although whole wheat bread is to be recommended in many cases, yet as that is not the only food used, some of the constituents of wheat can be supplied from other sources. The main thing is to eat in moderation, clean and well-

[1] Food and Dietetics, Hutchinson, p. 453.
[2] U. S. Dept. Agri. Office of Information, Sept. 21, 1913.

cooked food, or if the food is raw be sure that it is clean. Foods that are found to disagree with a person should be left out of the diet, for it should never be forgotten that the adage "What is food to one man may be fierce poison to others," is thoroughly scientific.

CHAPTER IV

SUGAR AND OTHER SACCHARINE SUBSTANCES

The desire for sweet substances seems to be universal in man and is not uncommon in the lower animals. The name sugar was at one time given to substances having a sweet taste, as sugar of lead, etc., but was later restricted to certain oxy-aldehydes and oxy-ketones, having the general formula $C_n(H_2O)_m$ which occur in the vegetable and animal kingdoms. The chief substances of this class from a chemical standpoint (see pp. 15–18) are:

Cane sugar ($C_{12}H_{22}O_{11}$).
Glucose ($C_6H_{12}O_6$).
Fruit sugar ($C_6H_{12}O_6$).
Lactose ($C_{12}H_{22}O_{11}+H_2O$).
Mannite ($(C_6H_8)(OH)_6$).

The important sources of sugar in nature are the sugar cane, sugar beets, sorghum or Chinese cane, sap of sugar maple trees, date palm trees, sap of ash trees of southern Europe, the bamboo, honey, raisins and milk of mammals.

History

The ancients were familiar with honey as the chief representative of this class of foods, although they also used sweet fruits. The first true sugar was prepared either from the juice of the bamboo or that of the sugar cane, and was probably first known in India.[1] It was very early introduced into China; the sugar cane was also cultivated in the valleys of the Euphrates and Tigris Rivers.

[1] The Story of Sugar—Surface, p. 15.

At first sugar was used as a medicine, but gradually came to be regarded as a luxury, and was partaken of only at special feasts. From Arabia through Egypt and finally by the Moors, sugar cane was introduced into Spain and the countries north of the Mediterranean Sea. In the fifteenth century cuttings were sent by the King of Portugal for planting in the Madeira and Canary Islands. From the latter country the sugar cane was introduced into Brazil early in the sixteenth century, and then into the West Indies, principally into San Domingo. It was not introduced into the American Colonies until 1750 at which time an unsuccessful attempt was made, to make sugar, in Louisiana. In 1791, however, the sugar boilers were more successful. The "ribbon or purple" cane, which was better adapted to the soil and climate of Louisiana was introduced in 1820 and since that time it has been the variety most extensively grown.

More recently new varieties have been introduced principally from Demerara. These seedlings have been grown originally from seed produced by the cane, each seed being selected and numbered. The results of growing each seed are carefully watched, poor stock is discarded, and promising canes propagated for different qualities, until those most suitable to different conditions of climate, and general environment are produced and ready for distribution.

It is interesting to note that about the time America was discovered sugar cost $275.00 per hundred weight in London, while four hundred years later, so great have been the improvements and so large is the production, it can be sold at less than $5.00 per hundred weight. Different countries successively have dominated the sugar industry. Spain and Portugal were the most prominent in the sixteenth century, then Antwerp was the center of sugar refining, and following 1585 London was the center of the sugar market. In the early part of the seeventeenth century more than half of the world's sugar was produced by the use of slave labor,. in Cuba, Porto Rico, Brazil, the French Colonies, Dutch Guiana and Louisiana.

The use of the beet for sugar making dates back to the experiments of Marggraff, a chemist in the University of Berlin,[1] who in 1747 was able to extract only 1.5 per cent. of sugar; fifty years later Achard his pupil only extracted 3.0 per cent. This industry was greatly stimulated by Napolean I, and in 1806 a bounty was offered by the French government for sugar produced in France. In 1812 the production had increased so that 1650 tons of beet sugar was placed on the market; the annual output of Europe is now over 8,000,000 tons. The raising of beets for the manufacture of beet sugar has become an important industry not only in France, but in Germany, Holland and America. The amount of sugar in the beet has been steadily increased by seed selection, better cultivation and adaptation to soil and climate until now it is not uncommon to find beets containing from 15 to 23 per cent. of sugar, although the average as produced in the United States is not more than 13 or 14 per cent. The beet is really richer in sugar than the sugar cane of Louisiana, which does not average more than 11 or 12 per cent. of sucrose.

Both cane and fruit sugar are found in numerous fruits; but the latter is the more abundant. Pineapples, contain 11.33 per cent. of cane sugar, strawberries 6.33 per cent., apricots 6.04 per cent., apples 5.28 per cent. (See table under fruits p. 210.) These fruits it is true are not adapted for use in making sugar, but the sugar is available, however, as will be seen later, for the production of alcohol and vinegar.

Cultivation of the Sugar Cane

The sugar cane (saccharum officinarum), which belongs to the family of grasses, grows best in a sub-tropical climate where the plant is not in danger of being killed by an early frost, as it is very susceptible to a low temperature. It is most successfully cultivated in Cuba, the West Indies, Louisiana, the Philippine and Hawaiian Islands, Java, and Brazil. Although cane may be raised

[1] Loc. cit., p. 110.

where the mean temperature is not below 66° F., it flourishes best at a mean temperature of from 75° to 77° F. It should also have abundant sunshine and moisture. In fact, cane grows best where there is at least 50 inches of annual rainfall and where half of this comes in the growing season in the late spring.

As a large amount of mineral and nitrogenous food is needed for this crop it is evident that even the best soils will ultimately be exhausted. This may be largely obviated by a careful rotation

FIG. 15.—Cutting sugar cane in La. (By permission C. S. McFarland.)

of crops, and the growing of peas, beans or clover which by their "nitrogen-fixing" roots help to restore the fertility of the soil.

The cane is propagated by cuttings which are best put in rather late in the fall. It is necessary to cultivate the cane thoroughly during the first months of the growing season, but later the ground is shaded by the crop so that the weeds do not grow so readily. As the cane matures the lower leaves are shed, and the joints change to a reddish color, especially in the purple variety. Late in the autumn, after the mature cane is cut, the young cane sprouts anew from the old roots. In the U. S. two crops are profitably gathered from one setting, and then new plants must be started. In many tropical islands, however, the sprouts from the old roots are cut year after year until the plants die, but profitable cultivation is only for from five to seven years from one planting. The cane is generally cut by hand labor, and is then hauled to the mill. (Fig. 15.) This hauling on the larger plantations in the United States, is done by means of special cars on a dummy railroad. The average cane production in the United States is 18 tons per acre[1] selling at $3.50 per ton. In tropical countries good cane contains from 15 to 18 per cent. of sucrose[2] and the extracted juice contains under favorable conditions 17 to 18 per cent. of sugar. About 95 per cent. of the total sugar can be profitably extracted in the modern mills.

There is a particular stage in the growth of the cane in which it is said to be ripe, or to reach its maximum of sugar content, then as inflorescence proceeds the extractable saccharine matter decreases. It is therefore of importance to cut the cane at just the right time. In tropical countries cane does not reach its full growth or ripest stage under twelve to fourteen months. To extend the cutting season over as much time as possible, the cane is planted at different times during a series of weeks, and in the following season, harvested in the same approximate rotation.

In Louisiana, the life of the cane is shortened by cold weather to a total of not over nine months and in consequence, its sugar content does not average above 11 or 12 per cent. A temperature of 28° F. will kill the cane and thus prevent further growth, and the deterioration of the crop after the frost is immediate.

MAKING CANE SUGAR

There are two general processes for obtaining the juice in making sugar; (1) that by grinding or crushing the cane, and (2) that of "diffusion." The former process is the one usually applied to sugar cane, and the latter to sugar beets.

[1] Ibid., p. 52.
[2] Cyclopedia of Am. Agri., Vol. 2.

MANUFACTURE OF SUGAR FROM SUGAR CANE

Grinding the Cane

After the cane is stripped and topped, in the "brake," it is hauled on cars to the "mill." In the larger establishments the cane is lifted from the cars by powerful machinery and "dumped" on conveyors which feed it in between the heavy metal rollers that squeeze out the juice. (Fig. 16.) In some mills the cane

FIG. 16.—Grinding cane in the Philippines. (Copyright, Keystone View Co.)

passes through a "shredder" of corrugated rolls before it is passed on to the crusher rolls. The rolls are usually so arranged that after the cane passes through one set, it is again pressed by a second and sometimes even by a third set. In the most complete mills at the present time as many as fourteen rolls, including the shredders, are employed, and some mills have a capacity of a thousand tons of cane in twenty-four hours. Between the first and second set of rolls the cane is often sprayed with hot juice, and between the second and the third set with hot water in order to increase the yield of sugar extracted.

The crushed cane which is called "bagasse," still contains a little sugar that it has not been possible to extract. The bagasse is dried by passing it over the boilers on conveyors, and is then used for fuel in the furnace.

Purification of the Juice

The juice which is quite dark colored and turbid contains considerable organic matter other than sugar. To remove this it

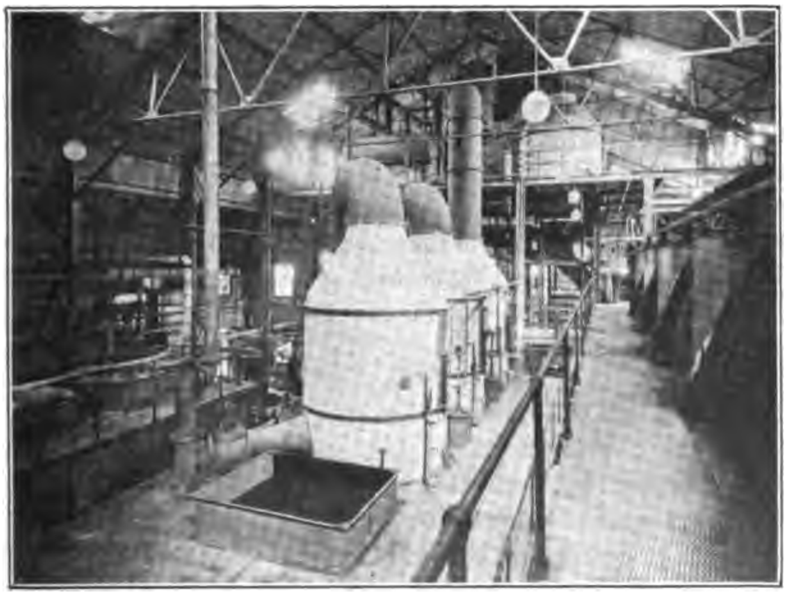

FIG. 16a.—Triple effect condenser, for concentrating sugar solutions.

is often treated with the fumes of burning sulfur, or with bisulfite of lime, and then heated with lime. This process is known as "defecation." The lime neutralizes any acid that may be in the juice and thus prevents some of the cane sugar from "inverting" or changing into the uncrystallizable invert sugar. The lime also causes a coagulated scum to form and this is skimmed or filtered off. This scum carries away many of the impurities of the juice, especially those of a nitrogenous character. It, however, retains considerable sugar, so that it is pressed by means of a heavy filter-press (see Fig. 321) to recover as much of the juice as possible. The residue or "press-cake" as it is called is sometimes utilized as a fertilizer. The expressed juice is added to the main portion of the juice to be afterwards treated.

Evaporation of the Juice

The clarified juice obtained by the defecation and filtering mentioned above, is evaporated in the so-called "multiple effect" vacuum pans. In the first pan of the multiple effect the air is exhausted to such an extent that exhaust steam from the engines and pumps of the factory will, when entering the steam jacket of the pan, cause the juice, under the partial vacuum, to boil and thus concentrate. The steam arising from the boiling juice of the first pan enters the jacket of the second pan, and as the vacuum of this pan is higher the temperature of the steam from the first supplies sufficient heat for further evaporation. This process continues in the entire battery of from two to five pans; that is the juice and vapor passing from one "effect" to the next, until the sirup is pumped from the last pan, and the final vapor condensed by a cold-water spray. It is evident that by this process a great saving of fuel is effected.

Sugar Boiling

The concentrated juice is next run into the "strike pan," (Fig. 17) which is a large boiler heated by steam coils, and connected with an exhaust pump so that a very high vacuum can be maintained. After the mass has begun to crystallize or "grain" additional sirup is allowed to run in from time to time, until the pan is finally filled with the crystalline sugar, mixed with molasses. In this high vacuum the concentrated sugar solution boils at from 150° F. to 180° F., so there is no danger of its burning.

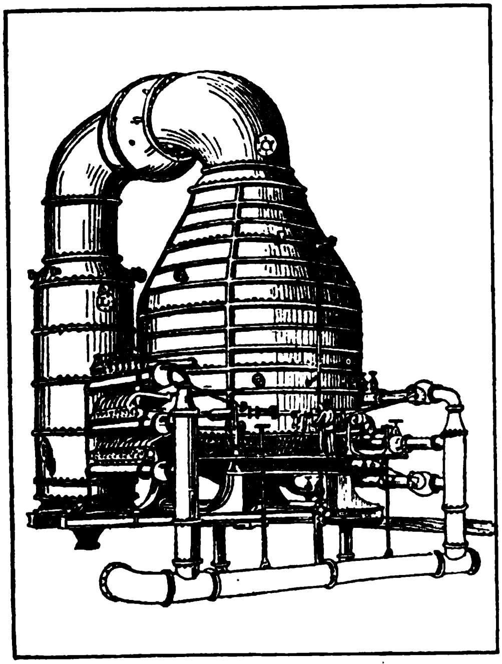

FIG. 17.—Vacuum Strike Pan, Farmers' Bull. No. 82. (By permission U. S. Dept. Agric.)

The Centrifugals

The warm mixture of sugar and molasses known as "masse cuite" is next stirred in a mechanical mixer so that it may be of uniform consistency, and is then run into the "centrifugal." (Fig. 18.) This machine was first successfully used for this purpose in 1860. It consists of a drum running on a perpendicular axis at the rate of 1000 to 1200 revolutions per minute. The sides of the drum are composed of perforated metal so that when the mixture of sugar and molasses is rapidly rotated or "swung out" the molasses is separated from the sugar. The sugar is washed with a little water just before it is dumped from the centrifugals. The sugar thus produced is dried and put upon the market. Sometimes salts of tin are used at this point in the process in clearing the sugar, and ultramarine blue is occasionally added to correct the slight yellow color. The use of the latter substance is to be deprecated as sugars containing ultramarine are not suitable for use in some of the arts, as for instance in making fruit sirups.

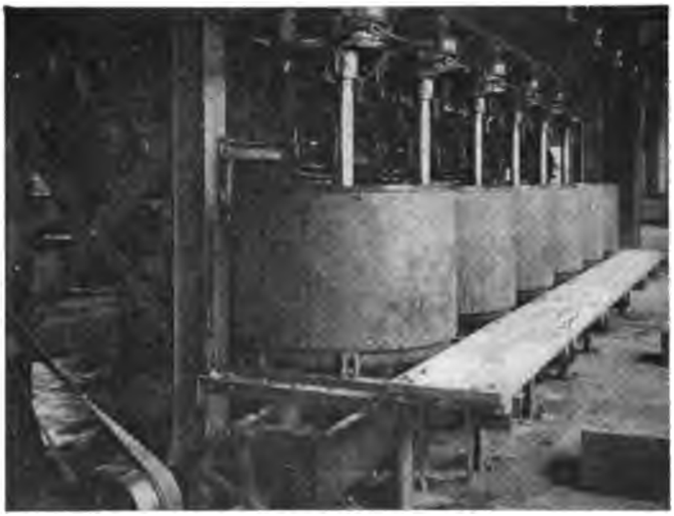

FIG. 18.—Mackintosh Centrifugals, S. S. Hepworth Co., New York.

The molasses and washings from the first "masse cuite" is reboiled and again run through the centrifugals to make a "second sugar," and the molasses from this is frequently concentrated to make a "third" sugar.

Muscavado or raw sugar is the crude product of the open-pan process of manufacture. These raw sugars are now imported into the United States for refining. Formerly both here and abroad such unrefined sugars as Demerara, Barbadoes, Cuban and Brazilian were in common use.

Cultivation of the Sugar Beet

In the cultivation of the sugar beet, the sugar content and purity of the juice depend not only on the variety planted, but on the soil, climate, weather and distribution of moisture. If possible the beets should not be harvested until the coming of the frost, as every day added to the growing season increases the sugar content.[1] In a mild climate beets can be stored in the open air until used but where there is danger of frost they must be kept under roof. The highest amount of sugar is obtained in irrigated regions where

FIG. 19.—Temperature zone in which the sugar beet attains its greatest perfection. (By permission U. S. Dept. Agric.)

there is an abundance of sunshine, and where the distribution of the water can be regulated. (Fig. 19.) The beet matures best where the average temperature of June, July, and August is about 70° F. The average per cent. of raw sugar extracted from the beet in the United States in 1908 was 12.6 per cent.; in Austria 17.2 per cent.; in Germany 17.5 per cent. The first successful sugar beet factory in the United States was built at Alverado in California in 1870, and has been in operation practically all the time since then.

[1] Beet Sugar Manufacture, Claussen.

THE MANUFACTURE OF SUGAR FROM THE SUGAR BEET

The Diffusion Process

After the beets are brought to the factory they are thoroughly washed, then passed into a machine in which they are cut by sharp revolving knives into small pieces called "cossettes." The

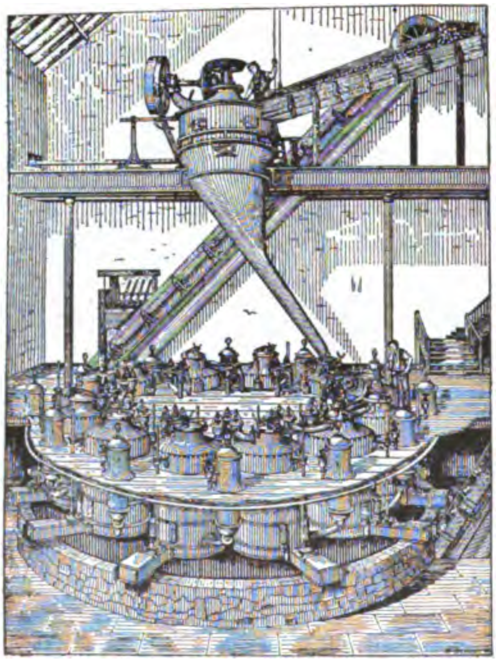

FIG. 20.—Diffusion battery for beet sugar, Farmers' Bull. 52. (By permission U. S. Dept. Agric.)

cossettes are placed in a "diffusion battery" which consists of a number of cylindrical tanks called cells so connected by means of pipes that the juice from the bottom of one "cell" flows into the top of the next. (Fig. 20.) There are large openings at the top of each cell for filling, and at the bottom for dropping out the spent chips. The saccharine juice increases in density as it passes through the chips. The warming of the juice to 75° to 80° C. in a heater placed between the cells, facilitates this process. The diffusors are connected in such a way that the more concentrated juice comes in contact with the freshly filled cells. Sugar, being a crystalloid is extracted by water through the principle of osmosis, leaving many impurities undissolved. When the chips are exhausted, they are dropped out of the vessel, sometimes pressed to obtain the last of the liquid, and finally sold as cattle food.

Purification of the Juice

In the process of the evaporation of the diffused beet juice, it is heated with lime, which neutralizes the free acid and assists in coagulating the nitrogenous matter. Carbon dioxide gas is passed through the solution, thus precipitating the lime, and setting free the sugar from the saccharate of lime that was formed. After filtering, this process called "carbonatation," is sometimes repeated. The juice is usually treated with sulfur dioxide gas which bleaches it, but care must be taken that the solution still remains slightly alkaline, otherwise inversion of the sucrose may take place.

The purified juice is evaporated as in the case of cane juice (p. 102). The molasses from the beet sugar process cannot be as readily used for making "second" and "third" sugars, as the molasses from cane sugar boiling. On this account the molasses is boiled down and treated with lime which precipitates calcium saccharate[1] ($C_{12}H_{22}O_{11} \cdot 3CaO$), which is separated from the solution by filter-presses, and the solid cake thus formed is returned to the "carbonatators," where it is treated with carbon dioxide gas, thus again setting the sugar free. Each beet sugar factory has its lime kiln, where the lime is burned and the carbon dioxide given off is collected and run into the carbonatation tanks, and the lime is used to precipitate the sugar as saccharate. Sometimes the purified juice is boiled to a fine grain and the strike is transferred to a

[1] Industrial Chemistry, Rogers-Aubert, p. 663.

granulator and from thence to the centrifugals, making only refined sugar in the process.

SUGAR REFINING

Most of the sugar that is imported into the United States and some of that from Louisiana and Texas is the crude product known as "raw" sugar, and contains from 2 to 3 per cent. of impurities. This is refined in the large refineries of New York, Philadelphia, Boston, New Orleans and San Francisco. In one of the largest of these refineries 13,000 barrels of sugar per day are refined.

The crude sugar is "melted" in warm water, filtered and then "defecated" with lime or with fresh blood from the packing houses. The solution is then filtered through long "bag" filters, and the clear but colored liquid is allowed to percolate slowly through bone black filters, which occasionally extend through several stories of the building. The colorless liquid thus obtained is now ready for concentration in the vacuum pan as described on p. 102. A second and a third sugar is frequently made from the molasses which is thrown out of the centrifugals.

Loaf and Cube Sugar

A modern process of making loaf sugar is to mix warm, granulated sugar from the centrifugals with a saturated solution of pure sugar, or thick sugar sirup, and to press this mixture into molds where it is allowed to harden. Cube sugar is made in a similar way. Formerly loaf sugar was made by running the masse cuite into conical sheet-iron molds perforated at the bottom. Here the molasses slowly trickled out, if the molds were kept warm, and the process was completed by washing the crystallized sugar in the molds several times with a *saturated solution* of granulated sugar to remove the molasses that adhered to the crystals. After the contents of the molds had been thoroughly dried the "sugar loaves" were removed crushed and sifted to form granulated sugar, or the sugar was sawed into slices, then into strips and finally into cubes, which were put on the market as "lump" or "cube" sugar. The retail price of this sugar in the United States is often out of all proportion to the extra cost of manufacture. Sugar loaves are still sold by the grocers on the Continent and the purchaser breaks them into lumps of any required size. The granulated sugar is somewhat more expensive.

Powdered Sugar

From the imperfect pieces or from the original sugar loaf, "pulverized," "powdered" or "icing" sugar is made by simply grinding in a mill and bolting. To prevent this sugar from becoming lumpy it is sometimes prepared for the market by mixing with it a small quantity of starch. Four grades of this sugar, which are of different degrees of fineness are made, but the XXXX is the variety in common use. It is often asserted by housekeepers and food manufacturers that there is a difference in the cooking quality of cane and beet sugar. Recent experiments[1] show that although beet sugar produces more froth in making sirup, this is wholly due to its fine granulation. There seems to be no difference in the keeping qualities of jelly or canned goods made by the use of either of the two sugars.

MANUFACTURE OF MAPLE SUGAR

It is probable that the North American Indians were the first manufacturers of maple sirup.[2] All species of the maple tree yield a sweet sap but the Acer saccharinum (sugar maple) and the Acer saccharinum nigrum are species best adapted sugar making.

Tapping the Trees

In order to obtain the sap, a hole about 1/2 inch in diameter is bored in the trunk of the tree, to a depth of 2 or 3

[1] U. S. Dept. Agri. Bur. Chem. Bull. No. 134.
[2] U. S. Dept. Agri. Bur. Forestry Bull. No. 59, and Vt. Agri. Ex. Sta. Bull. No. 103

inches. Sometimes a "spile" or pipe, made from elder wood with the pith removed, is driven in this hole to carry out the sap, but a more modern process is to drive in a metal spout just below the opening. To this a bucket, which should be covered, is attached to catch the sap. Much attention[1] has been paid to such questions as the side of the tree to be tapped, the number of holes relative to the size of the tree, the proper time of the year for tapping, and the best way of collecting and storing the sap. It is believed that the best flow of sap is obtained when the temperature is such, that it is freezing at night and thawing during the daytime.

Boiling the Sap

The sap, after being collected from the trees is stored temporarily in wooden or metallic tanks, and then boiled down as rapidly as possible. The evaporating is often done in a crude way by simply boiling in iron kettles over an open fire, but this method has been largely superseded by the use of rectangular sheet-iron pans, about 6 inches deep, which are heated directly over a fire. Better results are obtained if the pan is divided into several compartments so arranged that the greatest heat is under the pan containing the most concentrated sirup and the liquid as it concentrates is dipped or siphoned from one compartment to the next. The sap contains from 1.5 to 3 per cent. of sucrose.

Purification of Maple Sirup

Coagulation of the nitrogenous constituents of the sap takes place largely during the first stage of the boiling, and the scum thus formed must be frequently removed. Some makers use milk or white of eggs to assist the coagulation and the final concentration is often conducted in steam kettles. As the commercial value of a maple sirup depends quite largely on its color, it is advisable to strain the original sap, and also the sirup several times to remove

[1] Cal. Ag. Ex. Sta. Circ. 33.

any suspended matter. By this process the so-called "niter" or "sugar sand" (an impure malate of calcium), and suspended dirt are removed. Any carelessness in the methods of collection of the sap or in evaporating, will result in a dark-colored, strong-flavored sirup, which commands a lower price than that which is made more carefully.

Composition of Maple Sirup

Sirup that is carefully made and stored in sealed cans will keep for several years. A good sirup should weigh not less than 11 pounds to the gallon and should not contain more than 32 per cent. of water. The average amount of sucrose in a good quality of maple sirup is 62.6 per cent.[1] and the invert sugar 1.47 per cent. If the invert sugar is high it indicates that the sap has been allowed to sour, or that the sirup was carelessly made.

Formerly in the United States there were hardly any food products more frequently adulterated than maple sirup and maple sugar, but since the enforcement of the Food and Drugs Act of June 30, 1906, manufacturers are now required to state upon the label the true nature of the product.

Maple sugar and sirup are most extensively made in Ohio, New York, Indiana, New England, Pennsylvania, Michigan and West Virginia. Maple sirup and sugar are also made in Canada, but not in the South, west of the Missouri River, or in Europe. The total amount of maple sirup produced in 1909, according to the United States census reports, was 4,106,418 gallons.

Maple Sugar

Maple sugar instead of sirup, is readily made by carrying the process of concentration still further until the mass boils at about 240° F., and then pouring the hot sirup into molds to solidify. It is estimated that not over 14,000,000 pounds is made annually in the United States. This is never refined, as its value depends on certain ingredients other than sugar that give it an

[1] U. S. Dept. Agri. Bur. Chem. Bull. No. 134, Farmers' Bull. No. 516.

agreeable flavor, and these very substances would be removed in the process of refining.[1] The crop is now about equally divided between sugar and sirup, but the proportion of the latter is rapidly increasing. Much dark, inferior maple sugar is used in making the various mixed sirups which are placed on the market.

In the early history of the American Colonies in addition to honey, maple sugar was the chief sweetening substance, and was very cheap, but with the improved methods of making white sugar from the cane and beet, the price of white sugar has steadily fallen, while maple products, on account of the limited supply, have increased in value. At the present time the demand for maple sirup is partly met by the sale of cheap mixtures consisting of cane sirup flavored with maple, or with some flavoring material that at least "suggests" maple products. If properly labeled, there can be no objection to the sale of such products, although the price charged is often entirely out of proportion to the value of the ingredients used. Maple sap contains on the average about 2 per cent. of sugar. With sap of the ordinary composition, a barrel of sap (32 gallons) should produce a gallon of sirup or 7 1/2 pounds of maple sugar.

Palm Sugar

From the earliest times a sugar has been made in India, China and the East from the juice of various species of palms, and was known as "palm" sugar, "date" sugar or "jaggery." The juice, which is called "toddy," is obtained from incisions in the tree or the flower-stalk. (Fig. 21.) In making the sugar the sap is neutralized with lime, boiled, filtered and clarified as in the making of cane sugar. The product is of a low grade and moist, on account of the presence of considerable invert sugar. About 35 pounds of raw sugar may be obtained each season from a single tree.

An intoxicating beverage called "*palm wine*," is made by the fermentation of this sugar, and this when distilled forms the well-known spirit "arrack." This beverage, which is in common use

[1] Cyclo. Am. Agri., L. H. Bailey, Vol. 2.

among the Hindoos and Malays, often contains 50 per cent. of absolute alcohol. A lower grade of the same spirit is made from fermented rice.

Raw Sugar

The average composition of "Raw Sugar" from different sources is as follows:

FIG. 21.—Getting "toddy" from a palm tree.

Sugar from	Water	Cane sugar	Other org.	Ash
Sugar cane	2.16	93.33	4.24	1.27
Sugar beet	2.90	92.90	2.59	2.56
Palm	1.86	87.97	9.65	0.50
Maple	7.50	82.80	8.97	0.91

SUGAR AS FOOD

The time has long since passed when sugar is to be regarded as a mere luxury, although on account of the use of sugar in confectionery the luxury phase of the subject can never be ignored. In the process of plant growth the starch in the later stages is converted into sugar, and as far as nutritive value is concerned they are very much alike.

Starchy[1] food must first be acted upon by a ferment in the saliva, and then by a second ferment contained in the intestines, before it is in a suitable condition to be taken into the blood as a nutrient. Cane sugar, on the other hand, does not require as complex a treatment before it can be assimilated. It is, through the action of certain enzymes or ferments by the process of "inversion," changed in the digestive tract, into glucose and fructose[2] —simpler sugars—which are then ready for absorption. It is interesting also to note that when more sugar or starch is consumed than is actually needed, some of it is changed in the liver to a peculiar starchy substance called "glycogen" $(C_6H_{10}O_5)_x$, and is there stored for future use[3] or a part of it may be changed to fat for storage purposes. This glycogen is also stored in the muscles, especially during periods of liberal feeding, and is rapidly used up during active muscular work.[4]

It has been shown by experiments that as a part of a simple mixed diet 5 ounces of sugar per day can be consumed by a healthy adult, and 98.9 per cent. of its total energy become available in the body. The main function of the sugar or of the starch is to furnish heat and energy.[5] The experiments of Morro, an Italian in 1893 tended to prove that reasonable quantities of sugar in the food, delayed fatigue and at the same time increased the working powers, and later experiments have confirmed this fact.

[1] Food and Dietetics, Hutchison, p. 267–273.
[2] Chemistry of Food and Nutrition, Sherman, p. 10.
[3] U. S. Dept. Agri., Farmers' Bull. 93.
[4] Chem. of Food and Nutrition, Sherman.
[5] U. S. Dept. Agri., Farmers' Bull. No. 535.

Sugar is well adapted to help man in the performance of extraordinary muscular exertion. For this purpose it may be given in lemonade, or if a solid is desired mixed with chocolate. Its value has been proven in the German army by experiments with soldiers on the march.

Starch is a satisfactory food where muscular exertion is required, but if a part of this is replaced by sugar, there is less tendency to fatigue. As sugar has the advantage of being more readily digested, it is of special value for those individuals who have not the ability to digest starch. This is particularly true of infants for whom milk sugar is the natural diet.

There are many instances on record of the large consumption of sugar by workmen, and seemingly to their advantage; among these may be mentioned the negroes of the South, lumbermen working in the woods and mountain climbers in the Alps. As a feeding stuff for the lower animals sugar is already of importance in the South where "Black Strap" (the liquor left after the last crystallization of sugar) is a part of the regular diet of mules and sugar is fed to cattle and used for fattening steers.

As to the quantity of sugar that should be allowed in the daily ration, it has been ascertained that in many well-to-do families in the United States as much as 2 pounds per week per capita is used. This would mean in an ordinary family not less than 500 pounds per year. The amount of sugar used per capita in different countries varies with the climate, the habits of the people and very often with their financial ability to obtain it. This amount is however constantly increasing, for with sugar at 6 or even 7 cents per pound, it compares favorably with other foods as a source of energy, although more expensive than wheat flour and corn meal.[1]

As valuable in the dietary as sugar has been proved to be, there is danger in using too much, since an excess cannot be readily digested and will produce acidity of the stomach, and flatulent dyspepsia. This is particularly true in the case of persons living

[1] U. S. Dept. Agri. Farmers' Bull. No. 535.

a sedentary life, or having a tendency to corpulency. Children with their active lives, out of doors, and their rapid growth, can no doubt assimilate more sugar than adults, but on account of their fondness for it, there is danger of their eating too much and of its causing indigestion.

PRODUCTION OF SUGAR

According to Willett and Gray, it is estimated that in 1906 the total amount of sugar produced from cane was as follows:

	Cane sugar, tons
Louisiana	300,000 (in 1910, 341,994)[1]
Porto Rico	210,000
Hawaii	370,000
Philippines (export)	135,625
Cuba	1,300,000

Adding to this the amount of sugar produced from sugar cane in other countries, the world's production would be 4,957,525 tons. Adding the sugar produced from sugar beets to this, the world production of sugar would be 17,000,000[2] tons. Three-fifths of the sugar used in the United States is beet sugar, and more than half of the world's production is beet sugar. The greatest sugar beet states in order of production are Colorado, California, Michigan and Utah.

The total amount of beet sugar produced in 1910–11 in some of the leading sugar countries was as follows:[3]

	Metric tons (2204.6 pounds)
Germany	2,589,869
European Russia	2,108,760
Austria-Hungary	1,522,785
France	711,172
Belgium and The Netherlands	500,108
United States	462,529

[1] The average of the last few years in Louisiana has been 357,500 tons.
[2] Senate Doc. 890.
[3] U. S. Senate Doc. 890, Sixty-second Congress, Second Session, 192, p. 62.

The total amount produced in Europe was 8,032,741 tons, and the same year Germany exported 1,125,868 tons.

Consumption per Capita

The sugar consumption per capita (all kinds of sugar included) in 1910–11, and the retail cost per pound to consumers was as follows:

	Consumption per capita	Retail price per pound, 1911
Great Britain	91.63	5 cents
Denmark	84.23	5 cents
United States	79.20	5.69 cents
Switzerland	76.34	5.10 cents
Sweden	57.98	8.00 cents
Germany	47.91	5.90 cents
France	42.84	5.90 cents
Italy	10.10	14.00 cents
Servia	7.90–7.94	8.70 cents

In considering the amount of sugar used in different countries the controlling factor is the cost as represented by the amount of sugar that can be purchased out of the ordinary daily wage. In Germany where labor is cheaper than in the United States, sugar costs about as much, and in Italy, although labor is still more poorly paid sugar costs from 14 to 16 cents a pound. Germany raises its own sugar while in Italy there is a manufacturer's tax of $6.41 per 100 pounds, and an import duty of $8.67 per 100. The home production more than equals the comsumption of the country, but the cost of manufacturing is so high that it does not pay to export the sugar.[1]

GLUCOSE (Fruit sugar) ($C_6H_{12}O_6$)

The next important group of the carbohydrates is the glucose group (p. 17). These substances are closely related to the

[1] Daily Consular Trade Report, 1914, No. 5.

members of the starch-cellulose group, for both starch and cellulose on boiling with dilute acid are converted into grape sugar, thus:

$$\underset{\text{Starch or cellulose.}}{(C_6H_{10}O_5)_n} + H_2O = \underset{\text{Grape sugar.}}{(C_6H_{12}O_6)_n}$$

Fruit or grape sugar is also closely related to cane sugar, for as previously stated, it may be produced from cane sugar by inversion with acids and heat, the products being dextrose ($C_6H_{12}O_6$) and levulose ($C_6H_{12}O_6$). In a similar manner milk sugar breaks up into dextrose and galactose ($C_6H_{12}O_6$).

As the name fruit sugar implies, the chief sources of this sugar are the fruits. The amount of fruit or "reducing" sugar found in fruits varies between wide limits; thus in grapes there is 17.26 per cent., in figs 11.55 per cent., cherries 10.00 per cent., apples 8.72 per cent., pineapples 1.98 per cent., lemons 1.06 per cent. This sugar also occurs with levulose in honey, and can be obtained by the action of special ferments on starch, dextrin or cane sugar.

COMMERCIAL "GLUCOSE" (Grape sugar)

Within the past twenty-five years the production of an artificial sugar or sirup of this class has increased enormously. The process of manufacture depends on the simple principle of the "hydrolysis," as it is called, of starch by heat and dilute acid. The manufacture of the starch and its conversion into glucose are most economically conducted in the same factory. For this purpose, in the United States the corn (maize) is softened by steeping with warm water, and cracked to loosen the germs. The coarse meal then passes to the separators where the germs are floated off; these may be used as cattle food or for the manufacture of corn oil. The meal is then ground fine, and passed with water over shakers or through slowly revolving perforated cylinders to remove the hulls. The starch remains suspended in the milky liquid.

On the Continent of Europe potatoes are utilized for the manufacture of the starch for making glucose.

The next process consists in "inverting" the starch, which is accomplished in large copper boilers by the use of about 6 pounds of hydrochloric acid to 10,000 pounds of starch.[1] After this has been heated for some time under pressure, it will be found, on testing, that no starch remains. The free acid is then neutralized with sodium carbonate, the solution is decolorized by filtering through bone black, and concentrated in vacuum pans, by methods similar to those employed with cane sugar juice. Although it may be possible to "convert" the starch without the use of acid under special conditions, it has been found more practical to use small quantities of acid in the process. This acid is completely neutralized in the final product.

When commercial *glucose* is to be made, the process of converting is arrested while there is considerable uncrystallizable dextrin in the product. The concentration is carried only far enough to produce a heavy thick sirup. This contains about 35 per cent. of dextrose, from 4.6 to 19.3 per cent. of maltose and from 29.8 to 45.3 per cent. of dextrin.

Grape Sugar

For the production of commercial "*grape sugar*," the conversion of the starch is carried farther than for the glucose, and the concentration in the vacuum pan is carried so far that on cooling a non-crystalline solid remains. This contains from 72 to 99.4 per cent. of dextrose, and without doubt some caramelization has taken place in those products which are most concentrated. This gives the latter a brownish color, and the product is often used for making "glucose" or "grape" sugar vinegar, which is thus colored to imitate cider vinegar, and yet contains no "added color." Glucose is put on the market in various degrees of concentration known as "A," "B," and "C." Formerly in the process of

[1] Food Materials and Their Adulterations, Richards, p. 92.

making glucose and grape sugar sulfuric acid was used instead of hydrochloric to hydrolize the starch, and marble dust was added to produce calcium sulfate, and thus neutralize the free acid. The calcium sulphate was removed by settling and filtration.

Among the other products of the glucose factories are "mixing glucose," used in making table sirups (see p. 125) "jelly glucose" and "confectioners" glucose.

Glucose as Food

Glucose products are considered wholesome. In a report to the National Academy of Science,[1] the statement is made that "starch sugar is in no way inferior to cane sugar in healthfulness, there being no evidence before the committee that maize or starch sugar, either in a normal condition or fermented, has any deleterious effect upon the system, even when taken in large quantities."

A more recent authority[2] (1902), however, says: "Although prepared for immediate absorption from the stomach and intestine and for assimilation, glucose is of little service for flavoring other articles of food, for when so used it is apt to produce flatulent dyspepsia with acid eructations. . . . . If glucose be eaten as a food in form of candy or otherwise, it overloads the system by being too promptly absorbed."

The chief adulteration to which glucose is liable, is that it may contain a considerable quantity of sulfites, which are used in bleaching. If it is absolutely necessary to use sulfur dioxide or sulfites in the process of manufacture, an excess should be very carefully avoided, as this substance is not a wholesome constituent of food.

Glucose is very extensively used in the arts. It is a constituent of many table sirups; it is used in the manufacture of "white wine" vinegar; it is used as a sweetening substance in canned

[1] Report to U. S. Government by National Acad. Science, 1884.
[2] Thompson, Practical Dietetics, p. 132.

goods, jams and jellies; it takes the place of cane sugar in making caramel, and in confectionery; it is used in making artificial honey and as a substitute for malt in brewing. Glucose has not as great sweetening power as cane sugar. Some authors state that the relation is about as 3 to 5. The author found that 1 pound of cane sugar was equivalent to 1 1/3 pounds of glucose.[1]

In some states the contention is made that the term "corn sirup," is not a proper name to apply to a glucose product. A sirup is made by concentrating a natural juice or sap, but the starch product is entirely artificial. Again, it is said that on account of the prejudice of the public against the term "glucose" the word "corn" is used. It is held that the term corn sirup could be properly applied only to a sirup made by concentrating the juice of the corn stalk, and not to an artificial product which may be made, and indeed often is made from potato starch rather than from corn starch. This matter has been in litigation for some time, but by the ruling of the U. S. Dept. of Agriculture, the term "corn sirup" can be used in describing this glucose product.

The total amount of glucose and of grape sugar made annually in the United States is 1,000,000,000 pounds, and in this industry no less than 50,000,000 bushels of corn are used. This is nearly all made in a few factories which control the entire output.

MANNA

Manna is a saccharine substance exuding from various trees. The substance usually called manna, however, is from the juice of the *fraxinus ornus*, a species of ash which is grown in Sicily and other parts of southern Europe. The juice which exudes from slits made in the stem of the young tree, when it is dried, is known as "flake" manna. It has a sweetish taste and characteristic odor and contains a crystallizable sugar called "mannite" ($C_6H_8(OH)_6$), and several uncrystallizable sugars. It is used in medicine as a laxative.

[1] First Quar. Rep. 1885, K. St. Bd. Ag.

SOURCES AND METHODS OF MANUFACTURE OF MOLASSES AND SIRUPS

It is well to distinguish carefully between molasses and sirup. Properly speaking molasses or treacle as it is called in England, is the liquor which remains when the saccharine juice has been concentrated to the point of crystallization, and some of the sugar has been crystallized out. The "mother liquor," as the chemist would call it, from which the sugar has crystallized is the molasses. It contains besides sucrose, some of the uncrystallizable sugar of the original juice, and all the "invert" sugar produced in the process of manufacture; besides this all soluble impurities and the mineral salts of the original juice are somewhat concentrated here.

Sirup, on the other hand, is the product obtained by the simple evaporation of the original juice, from which no sugar has been removed. So we may have "sugar-cane" sirup, "sorghum" sirup and "maple" sirup.

Open Pan Molasses

In the primitive process of sugar making the defecated juice was boiled down in open pans or kettles, and passing from one to another as it reached a certain degree of concentration, was finally run into shallow tanks and stirred until it became a crystalline mass of sugar and molasses. This was put into hogsheads provided with holes in the bottom, and allowed to drain for some time. The resulting product, called "muscavado" or "raw sugar" was put upon the market, and the molasses which ran into cisterns beneath the hogsheads was shipped as "New Orleans" molasses. This process has now been practically abandoned, as not enough sugar was obtained to make it profitable.

Sugar Cane Molasses

In the manufacture of sugar by the vacuum process, as the drippings and workings of the first masse cuite are boiled down to make a second sugar, and often the drippings from this are boiled to make a third masse cuite—the third molasses necessarily contains all the impurities of a considerable amount of juice. These are, besides uncrystallizable sugar, mineral salts and organic matter. The last molasses is called, on the plantation, "black strap" and is fermented to make alcohol, or used in the manufacture of mule feed by mixing it with ground grains and alfalfa, in such proportions as to form a "balanced" ration. On account of the large amount of impurities contained it is not fit for human food.

Sugar Cane Sirup

An "open pan sirup,"[1] or "sugar cane sirup" which is very satisfactory, and should take the place of the molasses described in the previous paragraph is now made in many of the Southern States, especially Georgia, Alabama, Florida, Louisiana and Texas. This sirup is made by simply clarifying and evaporating the sugar cane juice to a consistency where 25 or 30 per cent. of water remains, and a product is obtained that keeps reasonably well. During the process the scum is carefully removed, and the final sirup is strained. No lime or sulfur is used in the process and, in fact, these chemicals are not necessary. Sulfur fumes are often used in products of this kind to bleach the material, but there is really no reason why a lighter colored product should be preferred, and the sulfuring certainly injures the flavor.

Many southern manufacturers still contend that the use of sulfur and lime are essential to produce a product that keeps well and does not crystallize.[2]

Sugar House Molasses (Refined Molasses)

In the process of sugar refining, which has already been referred to, a molasses remains after the crystallization of the third

[1] U. S. Dept. of Agri., Bur. of Chem. Bull. No. 70, 103.
[2] La. Bull. No. 129.

sugar, which is extensively used in making commercial sirups, as a flavor, or to disguise the glucose taste. This molasses is of a much lighter color than the product from the sugar factory (black strap), but contains a very large amount of soluble organic substances not sugar, and considerable mineral impurity. It is not a suitable food, unless properly used in the small quantities previously stated.

Sorghum Sirup

One of the common sirups in use is that made from the sorghum (Sorghum saccharatum) or Chinese cane. It appears that the sorghum plant originally grew wild throughout tropical and subtropical regions of the Old World.[1] Although very extensive experiments have been made under the direction of the U. S. Dept. of Agriculture,[2] especially in Kansas, it has not been found practical to use this juice for the manufacture of sugar. In some of the states of the Middle West, Kentucky, Tennessee, Missouri, Kansas and Texas, sorghum is grown extensively for the manufacture of sirup for local use. During and soon after the Civil War this industry was also carried on through the Eastern and Middle Atlantic States, on account of the high price of sugar, but more recently it has greatly declined. In 1879 more sorghum sirup was made in the United States, viz.: 28,500,000 gallons, than before or since. In India sorghum is largely used for making sugar, and many of its sugar products are exported.

Sorghum sirup is easily made on a small scale, as the cane can be grown as readily as corn and is easily crushed in a small mill run by horse power. The juice is evaporated in a series of shallow pans which allow skimming in the earlier stages of boiling. The addition of a little lime to the juice, and filtering of the decanted semi-sirup are recommended. Although this sirup is wholesome and nutritious, on account of its peculiar flavor it is not considered palatable by those unaccustomed to its use. It contains

[1] U. S. Dept. Agri. Farmers' Bull. No. 477.
[2] U. S. Dept. of Agri., Farmers' Bull. No. 90, No. 135.
Iowa Agri. Exp. Sta. Bull. No. 5

about 36 per cent. of sucrose, and 27 per cent. of reducing sugar. The yield of sorghum is 50 to 100 gallons of sirup per acre.

Commercial Sirups

Many of the sirups on the market are mixtures of various saccharine products, and have glucose (p. 118) as their base. This, as has been stated, is a colorless product, wholesome enough, but not so sweet as cane sugar. In making these mixed sirups, the commercial glucose is warmed[1] and into it is stirred some maple sirup, brown sugar, refiners' molasses, cane sugar molasses, or sorghum, as the case may be. In many states the manufacturer is required to state upon the label the per cent. of each ingredient used. The trade name used for the sirup must not be misleading at least in regard to the source of the product. The labels used on many of the commercial sirups are open to the objection that they convey a false impression as to the quality of the product. Sirups labled "maple and cane" or "cane and maple," usually contain only small quantities of maple. In mixtures of this kind the most abundant ingredient should always be placed first, and the size of type used should not be such as to be misleading as to which ingredient is most abundant.

The chief excuse for using these mixed sirups is that they are cheap. They are liable, however, to contain an excess of mineral impurities or bleaching substance which make them unwholesome. At any rate they can never compete either in delicacy of flavor, or in wholesomeness, with such products as pure maple sirup, or open pan cane sirup. An excellent and agreeable pure sirup may be made for home consumption by dissolving, by the aid of heat, two cups of granulated sugar in one cup of water. A small quantity of cream of tartar will prevent crystallization.

Adulteration of Sugar and Sirup

The adulterations to which molasses and sirup are liable have been already discussed. Sugar is sold at such a low price that in

[1] Foods and Their Adulteration, Wiley, p. 479.

the United States, at least, it is seldom adulterated. Ultramarine when added to granulated sugar (p. 104) is considered an adulteration, as are also the salts of tin, which are indeed poisonous. It may be permissible to add a little starch (not over 1 per cent.) to powdered sugar, so that it shall retain its pulverulent form and not become lumpy, but the addition of any mineral substances such as chalk, or magnesium for this purpose should not be permitted. No appreciable quantity of sulfites should remain in the sugar sirups or molasses, as these are injurious to health.[1]

Saccharin

Saccharin (benzoyl-sulphimide) $C_6H_4.CO.SO_2.NH$ is a white crystalline coal tar product, soluble in 400 times its bulk of cold water. When pure it is 550 times as sweet as cane sugar. Saccharine was discovered by Dr. Remsen and Dr. Fahlberg of Johns Hopkins University. In the United States, its use is not allowed in foods or beverages, and its manufacture is forbidden in Germany and Italy. It is not a sugar, neither does it possess any nutritive properties, and there seems to be considerable probability that if taken continuously into the system, it would be injurious. There is no excuse for its use in food, except that it may be of value as a sweetening substance in the dietetic treatment of certain diseases.

RUM

Rum is a beverage obtained by the distillation of fermented sugar cane juice or molasses. When any dilute saccharine liquid is treated with yeast and allowed to stand in a warm place, the sugar is changed to alcohol and carbon dioxide, thus:

$$C_{12}H_{22}O_{11}+H_2O=C_6H_{12}O_6+C_6H_{12}O_6$$

$$\underset{\text{Invert sugar}}{C_6H_{12}O_6}=\underset{\text{Alcohol}}{2C_2H_5OH}+\underset{\text{Carbon dioxide}}{2CO_2}$$

[1] Foods and Their Adulteration, Wiley, p. 480.

Sometimes the refuse of the sugar factories including the scum from the kettles is used in the manufacture of rum. In addition to the types of rum generally considered genuine, an imitation rum is made from the refuse from beet-sugar factories. A "mixed rum," which is artificial, is made by the "rectifiers," by mixing grain spirits, with some genuine rum perhaps, and bringing up the flavor by the use of ethyl butyrate and other ethers, "rum essence," prune juice, saffron extract, and oil of birch.

The characteristic flavor of old rum is due to the presence of ethyl butyrate, ethyl acetate and furfurol, which are developed in the process of "aging," by storing for some time in oaken casks. In genuine rum the per cent. of absolute alcohol is usually from 43 to 50, although much underproof liquor is sold.[1] (See p. 146.)

CONFECTIONERY

There is a continually increasing demand for confectionery. In the United States it is called "candy," and in England it is known under the various names of "sweets," "toffey," and "barley sugar."

The materials used in confectionery are so various that there is difficulty in classifying them, and the food chemist finds that no satisfactory standards have yet been made for these products. The basis of all confectionery, however, is cane sugar or glucose, and to this is added gum-arabic, flavors, extracts, colors, milk products, fruits, flowers, nuts, gums and special material such as caramel and chocolate. Starch is used in molding confectionery, and is also present in small quantities in the manufactured product. The presence in candy of any mineral substance, injurious color or flavor, liquor or drug is forbidden.

When granulated sugar costs $5.00 glucose can be bought for about $2.10 per hundred weight. Considerable gum-arabic and gelatin is also used, especially in making gum drops. For making

[1] Jour. Ind. & Eng. Ch. 1914, p. 73.

the best quality of cream candy and bonbons cane sugar only can be used.

Soft Candy

To make a soft candy about 25 pounds of sugar is heated with 1 gallon of water and a tablespoonful of cream of tartar, or a few drops of pure acetic acid or even lemon juice added to prevent crystallization. This mass is heated rapidly, usually in a copper kettle directly over the fire until the boiling temperature reaches 246° F., when it is poured on a marble slab, and partially cooled. It is then worked with suitable tools until it creams, an operation quite similar in its results to the "pulling" of candy. The product is known as "fondant" and is used as the *basis* for the manufacture of cream chocolates, and similar confections. It may be warmed and run into molds of various shapes which have been made in a bed of starch. For cream chocolates, these lumps of molded fondant are dipped when cold, either by hand or machinery, in a warm chocolate bath.

Hard Candy

For making stick candy a mixture of 9 pounds of cane sugar and 2 pounds of glucose may be taken and heated rapidly, with 2 quarts of water, to 310° F. to 330° F., then poured on the slab as with soft candy, and the flavor, usually an essential oil, added. In working the batch on the slab the edges are continually turned in toward the center. After it has been worked for some time it becomes somewhat hard and is thrown over a hook placed on the side wall, and "pulled" until it becomes white. This mass is then warmed and suitable portions are taken to a table and rolled by hand to form stick candy. Probably more than three-quarters of the stick candy is made in factories by machinery, but the general process is as stated.

Barley Sugar, Caramel

"Barley sugar" is a favorite confection in Europe, and is used in making other "sweets." It is prepared by heating sugar to (160° C.) 320° F., when it melts to a light brown, brittle, transparent mass, which has a characteristic taste and is sometimes slightly bitter. Caramel, "burnt sugar" or "black jack" is prepared by a still further heating of sugar to a temperature from 374° to 406° F. By this process although the chemical composition of the original sugar remains unchanged, the properties of the product are entirely different. Another process for making caramel is to heat glucose between 95° and 110° C., add carbonate and chloride of ammonium, raise the temperature to 150° C. and maintain that temperature for some time. Caramel is slightly bitter but gives an agreeable flavor to confectionery. It is extensively used to give a brownish color to food products and beverages. When the object is to make the product "appear better than it really is" this use is that of an adulterant.

Rock candy is made by dissolving cane sugar in a limited amount of water, and heating to 230° F. In this solution strings are suspended and, as the solution cools, the sugar crystallizes upon them. In order to obtain good crystals the sugar solution must stand for several days in a warm room, where the cooling can take place but slowly. If flowers or fruits are suspended in the sugar solution the product is known as "crystallized" flowers or fruit.

Chewing Gum

The making of chewing gum has become such an important industry that no less than $9,000,000 is invested in the business in North America and England. Originally the gum used was that of the spruce, cherry, etc., but the demand became so great that a gum known as "chicle" is now used as the basis of practically all the chewing gum of commerce. This gum is made from the milky sap of the sapodilla which is a native of tropical America. The tree bears a small fruit which has a firm, sweet pulp with a taste something like maple sirup. The gum is produced especially in Mexico, Central America and Yucatan. Incisions are skilfully made in the bark, and the juice obtained is boiled to a proper consistency and molded into bricks for export. If of first quality, it is firm, nearly white, aromatic and nearly tasteless. Chewing gum, if prepared with care, is nearly white, and free from dirt and other foreign material.

Adulteration of Confectionery

The addition of flavoring and coloring substances to candy is not of course considered an adulteration, but care must be exercised that they are not of an injurious character. Vegetable and a few animal colors are admitted to be satisfactory, but mineral colors are universally condemned. There is a large class of so-called coal tar or anilin colors that have come into common use for coloring confectionery, as they are made in great variety and are extremely brilliant.

Seven of these, after careful examination by the Department of Agriculture at Washington,[1] have been approved and are known as "certified dyes." Besides these seven there are no doubt others which are harmless, but as almost every possible color can be produced by the proper blending of these, it seemed best to thus limit for the present the number of permitted dyes in food products.

In the use of glucose bleached by sulfites lies another danger. Although in most cases the amount of sulfite introduced into candy in this way is small, there is always the danger that a large amount of "bleach" was used on a discolored batch of glucose with the result that the candy-maker unwittingly gets into his finished product an excessive amount of sulfites. It is stated that most of the glucose now appearing on the market is not bleached by the

[1] U. S. F. I. D. No. 76, Certified Colors.

use of sulfites. The use in candy of mineral substances, poisonous colors or flavors or anything injurious is discouraged by all reputable confectioners. In the United States the sale of chocolate or other confectionery, coated with shellac or any other inedible gum, is not allowed.[1]

In the United States it is estimated that over $80,000,000 per year is spent for confectionery, and the industry employs 40,000 persons at an annual wage of $15,000,000, who work up about $45,000,000 worth of material. As an illustration of the demand for confectionery, it may be stated that during the Spanish War, one New York firm[2] shipped over 50 tons of confectionery to the troops in Cuba, Porto Rico and the Philippines.

HONEY

Honey is defined by the Association of Official Agricultural Chemists, and by most food chemists as the nectar and saccharine exudations of plants, gathered, modified and stored in the comb by honeybees (Apis mellifica and Apis dosata). The sap of certain trees sometimes gathered by bees, or the product obtained by feeding the bees sugar sirup or glucose, cannot be regarded as true honey. (See Farmers' Bulletin, No. 653, 1915.)

History

From the very earliest history of our race, we read of the use of "wild honey" which was stored as food by the bees in the crevices of the rocks, and in hollow trees. On account of its sweetness and delicate flavor, it was regarded as a luxury and at the same time a delicious addition to the daily food. The honeybee is also one of the most beneficial of insects on account of cross-pollinating the flowers of various economic plants. There are quite a number of instances on record in which numbers of people have been poisoned by eating honey which the bees had gathered from poisonous

[1] U. S. F. I. D. No. 119.
[2] Practical Dietetics, Thompson, p. 131.

flowers. Sometimes this honey causes headache, nausea, and a kind of intoxication, but the results of the illness are seldom fatal.

As sufficient honey could not be obtained from the stores of the wild bees, man soon learned to raise the swarms in hives, under his own control. The hives[1] are so constructed as to afford the bees protection against inclement weather and to allow the removal from time to time of "frames" or boxes which the bees have filled with honey. The invention of the movable frame hive in 1851, by L. L. Langstroth of Philadelphia, marked a great advance in this industry.[2] These hives hold from eight to ten frames, and one of their best features is making the spaces between frames, side walls and supers accurately so there is just room for the easy passage of the bees. A comb foundation stamped from wax upon which the bees start to build their combs is often placed in each box.

FIG. 22.—Automatic reversible honey extractor. (By permission U. S. Dept. Agric.)

Comb Honey vs. Extracted Honey

Honey is frequently put on the market as comb honey, and in this form is not liable to adulteration, but there is also a demand for strained honey. The comb honey commands a better price and usually retains to the greatest extent its delicate flavor. Extracted honey or strained honey is more suitable for shipping long distances. The honey is usually extracted by carefully cutting with a knife the top of the honey cells and then spinning the honey out with a centrifugal machine. (Fig. 22.) The comb by this method is left in a condition to be re-

[1] U. S. Dept. of Agri. Farmers' Bull. No. 59.
[2] Cyclopedia of American Agriculture.

turned to the hive for refilling. From broken fragments of comb "strained honey" is allowed to flow by gravity, and the remaining fragments of comb are washed, melted and strained for commercial beeswax. The latter is bleached either artificially or by sunlight to make "white wax." Refiners often blend different kinds of strained honey to obtain an agreeable product.

Composition

Genuine honey is a mixture containing not more than 8 per cent. and usually not over 2 per cent. of sucrose or crystallizable sugar, and an average of 75 per cent. of the two sugars, levulose and dextrose, taken together.[1] The average amount of moisture is about 17 per cent. and the ash 0.18 per cent. Whenever the dextrose is in excess of the levulose the presence of adulterants is to be suspected.

Honey as Food

On account of the inverted condition in which most of the sugar occurs, honey is generally regarded as a very wholesome food. It is actually richer in sugar than the "malt extracts" recommended for invalids; and as the sugar is in a form that may be readily assimilated if taken in moderate quantities, it forms a valuable addition to the diet.

Adulteration

The most common adulterants of honey are cane-sugar sirup, glucose and a product made by the inversion of cane sugar by acids. The presence of these can, however, be detected by the chemist, and since the enforcement of National and State food inspection laws, adulterated strained honey, which was formerly one of the most common products on the market, has been almost completely eliminated. A method of falsification formerly practised was to place some honey comb and a few dead bees in the

[1] U. S. Dept. Agri. Bur. Chem. Bull. 110, p. 52.

can of so-called honey in order to convey the idea that the product was genuine. If the honey is purchased in the comb as capped with wax by the bees, there is little danger that it is not genuine. It is true that bees may have been fed on glucose or cane sugar, but as they do not thrive on this diet, the practice is not very common.

Favorable Localities

In the United States, honey can be produced almost anywhere, but in northern regions the winters are sometimes so severe that the bees do not survive, and in some sections flowers yielding nectar are not abundant enough. The locality has therefore considerable influence on the quality of the product. An interesting illustration of this is in the fact that the Hawaiian honey shows a larger amount of common salt in the ash than do other honeys, and in the lower grades there is so much "honey dew," which is gathered by the bees from the exudations produced by various scale insects and plant lice, that this honey has sometimes been suspected as not being genuine.

Quality

The quality of honey is much influenced by the character of the flowers visited by the bees; so we have "buckwheat" honey which is dark and has a strong flavor, "white clover" which has the reputation for possessing a most delicate taste. The honey made from the flowers of the alfalfa, mellilotus, golden rod, apple tree, gum tree and basswood has in each case a characteristic flavor. In Abyssinia a peculiar wine is made by the fermentation of honey. Mead and metheglin are also alcoholic beverages made by the fermentation of honey.

Statistics

In regard to the production of honey in the United States the statistics show that California produces the largest amount.

Other important honey-producing states are New Hampshire, Pennsylvania and Ohio. In the Eastern Hemisphere the most honey is produced in the Mediterranean region.

The average annual yield per colony in the United States is 25 to 30 pounds of comb honey or 40 to 50 pounds of extracted honey.[1]

[1] U. S. Dept. Agri. Farmers' Bull. No. 447.

CHAPTER V

ALCOHOLIC BEVERAGES[1]

Alcoholic beverages may be divided into two classes:

(A) Fermented beverages.

The fermented beverages are sub-divided into two classes:

1. Those fermented without the addition of yeast.
2. Those fermented with the addition of yeast (Malt Liquors).

(B) Distilled beverages.

A. FERMENTED BEVERAGES

1. Those beverages fermented without the addition of yeast are wine, cider, perry and similar beverages made by the fermentation of saccharine fruit juices, and a few beverages made by the natural fermentation of starchy solutions. Beverages of this class are discussed each under its appropriate source. (See pp. 263, 233.)

Malt Liquors

2. Those beverages fermented with the addition of yeast include ale, beer, lager beer, porter and stout.

History

The manufacture of some fermented liquors from grains is of very ancient origin, at least 2,000 years old. The process was known to the ancient Egyptians, Romans, Spaniards, and Germans, and was introduced by the latter into Great Britain and later

[1] Beverages, both non-intoxicating and intoxicating, are classified under the general head of foods, and are therefore here discussed.

into the United States. The knowledge of alcohol as a constituent of wine or beer was not known until the time of Marcus Graccus, who wrote in the twelfth or thirteenth century of the distillation from these beverages,[1] of a substance called "aqua ardens."

The knowledge of a process for making beer seems to be nearly as old as that for making wine; but the Greeks and Romans regarded beer as a barbarian drink. Beverages brewed from such cereals as rice, millet, rye and barley are common in Africa, Russia and China.

Chemistry of Beer Manufacture

Malt liquors, although primarily made from malt, or "sprouted barley," may be made from the infusion of wheat, rye, oats, rice, corn (maize), with the addition of other substances such as beet roots, potatoes, sugar, molasses, glucose, etc., in fact all that is necessary is to have a starchy or saccharine substance capable of fermentation with yeast.

Yeast (Enzymes)

Our knowledge of fermentation was very imperfect until 1857 when Pasteur showed that yeast consisted of living organisms capable of growth and multiplication. In 1897 Buchner[2] submitted yeast to great pressure and isolated from it a nitrogenous substance, enzymic in character, which he called "zymase." This body is formed continually in the yeast cell, and decomposes the sugar which has diffused into the cell. This yeast juice causes solutions of cane sugar, glucose, levulose and maltose to ferment with the production of carbon dioxide and alcohol; but has no action on milk sugar and mannose. This enzyme probably cannot be produced except by the action of the living protoplasm. This seems to point to the theory that there are two classes of ferments which bring about the changes called fermentation; viz., soluble

[1] Daniel, P. Sci. Mo. Vol. 82, p. 567.
[2] Ber. d. D. chem. Ges., 1897.

unorganized ferments like zymase, and insoluble organized ferments, which are minute vegetable growths. Chemical reagents bring about reactions which are analogous to the changes brought about by the unorganized ferments, as for instance, boiling with dilute acid perfectly imitates the hydrolytic action of diastase on starch.[1] (See also p. 14.)

Lavoisier was the first chemist to study fermentation from a quantitative standpoint. Gay-Lussac first proposed in 1815 the reaction with which we are familiar, representing the chemical change which takes place during alcoholic fermentation:

$$\underset{\text{Sugar}}{C_6H_{12}O_6} = \underset{\text{Carbon dioxide}}{2CO_2} + \underset{\text{Alcohol}}{2C_2H_5OH}$$

The most important of the soluble unorganized ferments, as noticed above, is "diastase." This is formed from the abluminoids of such cereals as barley, especially during the process of germination. Its action on the barley is to change the starch of the grain to dextrin, maltose and dextrose.[1] Thus:

$$C_6H_{10}O_5 + H_2O = C_6H_{12}O_6$$

Invertase is another soluble unorganized ferment and is capable of converting cane sugar or sucrose into invert sugar, thus:

$$C_{12}H_{22}O_{11} + H_2O = 2C_6H_{12}O_6$$

This enzyme is contained in yeast and can be readily extracted from it, by filtration and precipitation with alcohol.

The organized ferments or vegetable growths are divided into molds, yeasts, and bacteria.[2] The most important fermentation industries are dependent mainly on the action of yeasts and bacteria. On the phenomena of alcoholic fermentation are based the baking, malt liquor, wine, and spirit industries. On acetic fermentation depends the vinegar industry (see p. 235) and the cheese and other milk industries on lactic and similar fermentations. (See p. 414.)

[1] Industrial Org. Chem. Sadtler. p. 203.
[2] Sadtler, loc. cit.

Malting

In the manufacture of *malt*, the important points are to furnish the best conditions under which barley may germinate, and having allowed this process to go on long enough, to stop it by drying and heating in a kiln.

The grain is first steeped in a cistern of water at a temperature of about 60° F. from two to three days, and is then thrown out of the cistern and piled in a heap or "couch" upon the floor where it heats and the process of germination begins. The temperature is controlled by gradually spreading the grain in thinner and thinner layers on the floor, and by frequent turning or ploughing. The grain remains on the floor for ten or twelve days or until the rootlets have started, and the germ has grown to be about two-thirds the length of the grain. By this process the starch of the grain is changed to soluble maltose, dextrin, etc. In order to remove carbon dioxide, which is given off during germination, a pneumatic process in which cold, moist air is blown upward through the heaps of grain lying on a perforated floor is sometimes used.

Kilning

In the drying process the moist malt is heated first at a lower temperature and finally at a higher temperature sometimes up to 180° F. The terms "pale," "yellow," "amber" and "brown" are applied to different varieties of malt, the color being dependent on the temperature used in the kiln, and the way the heat is applied. Chemical changes continue to take place in the first part of the drying process. This drying requires three or four days, then before it is stored the germs and rootlets are sifted from the dried malt.

Mashing

The malt is coarsely ground and heated with water to extract the maltose and dextrin of the malt and to allow the diastase of the grain to act still further on the starch in order to change it to maltrose and dextrin, and at the same time to allow the peptose to act upon the proteins and form peptones. The extract thus obtained is known as the "wort." There are numerous malt substitutes, which are often introduced into the "wort." These include corn, rice, rye, oats, barley (unmalted) and glucose.[1] There is sufficient diastase in the malt to change to sugar considerably more starch than contained in the malt itself, and for this reason these malt substitutes can be used. The amount should not be over 30 per cent. In some countries, as Bavaria, the use of malt substitutes is prohibited by law.

Boiling the Wort

The extract, as obtained by the methods mentioned in the previous paragraph, is drained from the residue and run into a copper boiler, where it is boiled with hops, in the proportion of from one to three parts of hops per hundred of malt. This process concentrates the wort, extracts the flavor of the hops, causes the unchanged starch to separate out, and sterilizes the product so that it will keep better. After boiling, the wort is cooled as rapidly as possible. Hops which are the cones or strobiles of the *humulus lapatus* contain 4 per cent. of tannin, 1 to ½ per cent. of a fragrant volatile oil of alkioid called *lupulin*, a bitter principle, and a large amount of resin. They are extensively grown in southern England, Germany, Belgium, and in California, Oregon, Washington and North Dakota.

Fermentation

There are two methods of fermentation in common use: the "top fermentation" and the "bottom fermentation." In the first of these the process takes place more rapidly and at a higher temperature. In the second (which is followed especially in Germany, Austria and in the United States for lager beer), the fer-

[1] Glucose, sugar and bodies of this class are added just before adding yeast.

mentation goes on more slowly, and the beer usually has better keeping qualities. To bring about the fermentation, yeast is added in the proportion of one-half to three-fourths of a gallon to 100 gallons of wort, and the liquid is allowed to ferment for perhaps eight days, and is then drawn off into casks, stored in cave cellars where the after-fermentation takes place. After standing a sufficient time it is cleared by the use of a little isinglass, and a small proportion of a freshly fermenting beer is added to it to give it a "head," before it is placed on the market.

The following analyses give a general idea of the composition of ordinary malt liquors:

Beer	Water	Alcohol by weight	Extract	Nitrogenous substances	Sugar as maltose	Gum or dextrin	Ash
Schenk	91.11	3.36	5.34	0.74	0.95	3.11	0.20
Lager	90.08	3.93	5.79	0.71	0.88	3.73	0.23
Export	89.01	4.40	6.38	0.74	1.20	3.47	0.25
Bock[1]	87.87	4.69	7.21	0.73	1.81	3.97	0.26
Weiss beer[1]	91.63	2.73	5.34	0.58	1.62	2.42	0.15
Porter[1]	88.49	4.70	6.59	0.65	2.62	3.08	0.36
Ale[1]	89.42	4.75	5.65	0.61	1.07	1.81	0.31
Average 26 samples Am. malt liq	....	4.48	4.61	0.47	....	......	0.30
Munich Hofbrau	....	2.95	5.87	....	....	......	......
Pilsener	91.15	2.75	4.97	0.37	....	......	0.20
Munich bock beer	88.77	3.25	7.23	0.71	0.90	......	0.27

Varieties of Beer

Berlin weiss-beer is brewed from malted wheat, and some malted barley. English ale is brewed by surface fermentation, while porter is a dark liquor made from brown and black malt, and is high in alcohol. Stout is stronger than porter, and con-

[1] König Ch. d. men. Nah. u Genussmittel, pp. 806–851.

tains more extractives and 6 to 7 per cent. of alcohol. The German lager beer is made by the bottom fermentation process, and is brewed in winter for use in the summer. Bock beer is a stronger lager beer, and is brewed especially in the spring. The term "lager beer" (from the German "lager," a storehouse) was originally applied to those beers which were made in the winter and stored in a cool place for consumption the following summer. Much of the so-called "lager" in use in the Unite States is a "present use" beer, in which fermentation is still active.

In some localities where prohibition laws prevail, an endless variety of so-called "near beers" are on the market. The label has very little to do with describing the contents of the bottles. The amount of alcohol varies from a trace to over 2 per cent. The U. S. Revenue Department has ruled that any beverage containing more than 0.50 per cent. is subject to a revenue tax. Some of these beverages have most of the characteristics of beer, except that the alcohol has been finally removed by steaming.

Action of Beer on the System

Aside from the direct action on the system of the alcohol (see p. 150) the hop extract in beer causes it to induce drowsiness, and it also acts as a tonic in some cases. It produces biliousness in persons of weak digestion, and has a tendency to act as a fat producer, and if used in excess to produce obesity and to greatly distend the stomach.

On account of the extractives present, beer contains more nourishment than any other alcoholic beverage. It does not follow from this however that the beer is to be recommended as an economical food, for, as we have seen, alcohol is to be regarded as a food of only limited value.[1]

Adulteration of Malt Liquors

Aside from the substitution of other grains and saccharine materials for barley, the adulterations of beer are not very

[1] Food and Dietetics, Hutchinson, p. 352.

numerous. Other bitter principles such as quassia and gentian which are cheaper than hops have been used; but poisonous or injurious bitter substances are very rarely found in beer. Preservatives, such as salicylic acid and sulfites, and caramel as a coloring material are sometimes present.

Statistics

The amount of beer used per capita in 1905 in three leading countries is reported as follows:

	Gallons
German Empire	26.3
United States	19.9
United Kingdom	27.9

B. DISTILLED BEVERAGES
(Grain Alcohol)

The common distilled liquors are whiskey, rum, gin and brandy. (See p. 145, 147.) Besides these there are numerous other products obtained in different countries by fermentation and subsequent distillation of dilute saccharine liquids, or by the distillation of fermented starchy materials.

Materials Used

The raw materials used in the manufacture of alcohol and distilled liquors are of three classes: (1) weak alcoholic solutions as wine and cider, which by distillation yield a more concentrated alcoholic beverage, which frequently has especially on standing for some time an improved flavor; (2) sugar-bearing material, such as molasses, raw sugar, sugar factory by-products, sugar beets and beet molasses and the sweet juice of various fruits; (3) starchy materials such as corn, rye, rice, barley and potatoes. These latter are the cheapest source for the manufacture of alcohol.

Manufacture of Alcohol

The raw and malted grain, previously ground, is agitated for several hours in a mash tub with water, heated to 150° F.,[1] in order to convert all the starch (by the action of the diastase of the malt) into maltose. A second "wort," which is added to the first, is made after drawing off the liquor from the "mash." In Germany where potatoes are largely used, they are steamed under a pressure of two or three atmospheres, before being treated with malt to change the starch to sugar. In any case the chemical reaction is represented thus:

$$\underset{\text{Starch}}{C_6H_{10}O_5} + H_2O = \underset{\text{Sugar}}{C_6H_{12}O_6}$$

The next step is *the fermentation of the "wort."* The wort, as prepared by the previous process, is cooled and treated with "surface" yeast as it is called, in the proportion of 8 or 10 liters of brewer's yeast to 1000 liters of grain mash, at a temperature of about 92° F., and the process is completed in from three to nine days. If the fermentation takes place at a considerably higher temperature, some lactic acid is developed, and this is then known as the "sour mash" process. The chemical reaction illustrating the change that takes place during the fermentation of the wort is:

$$\underset{\text{Sugar}}{C_6H_{12}O_6} = \underset{\text{Alcohol}}{2C_2H_5OH} + \underset{\text{Carbon dioxide gas}}{2CO_2}$$

The next stage is *the distillation of the fermented wort.* This operation requires much skill and an elaborate system of boilers and condensers—the object being to free the alcohol as far as practicable from water, and to carry over with the alcohol as few impurities as possible. The distillate from the fermented mash is not strong enough for commercial purposes, it must therefore be further *rectified and purified.* These first distillates or spirits are often called "low wines." If the alcohol is obtained from potatoes,

[1] Sadtler, Industrial Organic Chemistry, p. 241.

special precautions are taken to separate out the "fusel oil" before the second distillation, by filtering the dilute alcohol through wood charcoal, or by shaking with petroleum oils.

Standards for Alcoholic Liquors

The result of the final distillation is an alcohol known as "rectified" alcohol of the British Pharmacopœia, containing 90 per cent. by volume of absolute alcohol and having a specific gravity of 0.834; or by the U. S. Pharmacopœia alcohol is defined as a spirit containing 94.9 per cent. of absolute alcohol by volume and having a specific gravity of 0.816 at 60° F. "Proof spirit," as the term is used in the United States by the Internal Revenue Service, must contain 50 per cent. by volume of absolute alcohol, having a specific gravity of 0.7939 at 60° F. This proof spirit has a specific gravity of 0.9335 at 60° F. Liquors having a greater alcoholic strength are "above proof" and those less, "below proof."

There is a strong tendency for alcohol to unite with water, so that it is difficult to prepare an *absolutely* water-free alcohol. When we mix together 53.9 volumes of alcohol and 49.8 volumes of water the temperature of the mixture rises, as if a chemical reaction took place, and after the mixture has cooled, instead of there being the sum of the amounts of liquids used, viz., 103.7 parts, only 100 parts are present, hence a kind of condensation has occurred.

WHISKEY

This liquor, if genuine, is made from the fermentation and distillations of the wort of corn (maize) rye, and barley. Scotch and Irish whiskeys are made from malted barley—mixed with other grains. The flavor of Scotch whiskey is due to the use of malt dried over a peat fire. Kentucky Bourbon whiskey is made by the use of partially malted corn and rye, while the Monongahela whiskey of western Pennsylvania is made by the use of rye with 10 per cent. malt. Irish "poteen" whiskey has a similar flavor obtained by the addition of one or two drops of creosote per gallon of whiskey.

Grain whiskey is made from the unmalted grains, which are ground into meal. An opportunity is afforded in this product to introduce into the mash almost any starchy or saccharine substance such as molasses, glucose, potatoes, turnips, beet roots, etc. Much of the whiskey on the market is compounded from "grain spirit," (alcohol) mixed with a small per cent. perhaps of genuine whiskey, and flavored and colored to suit the trade.

A freshly distilled whiskey is called *raw* whiskey, and is not considered fit to drink. When put away in barrels for some time various chemical changes take place, the higher alcohols being converted into aldehydes and ethers, whereby the flavor and aroma are much improved. The color of genuine whiskey is partly due to the material from which it is made, and partly to the wood in which it is stored. Many processes have been devised for the purpose of "aging" whiskey artificially in a short time, for when it is aged by storage, from five to eight years are required to produce a satisfactory flavor.

"Moonshine" whiskey is a product made in the mountainous sections of the United States from corn, rye or potatoes by the most crude methods and without the supervision of the Internal Revenue Department of the Government. As the revenue tax is $1.08 per "proof" gallon on the alcohol made, as well as a tax on the still, the temptation to evade the law is great.

RUM

Rum, if genuine, is a spirit made from the fermentation and distillation of sugar cane molasses, especially in the West Indies and Medford, Mass. New rum, which has a harsh, disagreeable odor and contains furfural and other impurities, is purified by treatment with charcoal and lime. Its characteristic flavor is due to the presence of butyric ether. Besides the genuine Jamaica rum and Demarara rum, there are numerous imitations and mixed rums on the market, which are made from grain spirit flavored with butyric ether, and colored with burnt sugar. (See p. 126.)

GIN

This liquor is made by distilling grain spirit with juniper berries. "Hollands," or "Schiedam Schnapps," is a well-known variety distilled in Schiedum, Holland. "Old Tom" is a kind of gin made in London by sweetening with cane sugar sirup; Irish gin contains various narcotic and flavoring substances. Much of the gin sold in saloons and resturants is simply grain spirit combined with oil of juniper, turpentine, and various flavoring extracts. Gin is a colorless liquor, and is supposed to have a medicinal value due to the essential oils and aromatic principles which it contains.

LIQUEURS AND CORDIALS

These alcoholic beverages are made from alcohol, sweetened and flavored with various aromatic herbs, essences, and extracts and often colored red, blue, yellow or green with vegetable colors. Sometimes the herbs or fruits are distilled with brandy and grain spirit.

Some of the best-known beverages of this class are:

"Absinth," which is a popular beverage in France, and is prepared from spirit, flavored with wormwood, Angelica root, calamus, and other aromatics, and colored green by the maceration of the green leaves of wormwood, hyssop, and mint. It was introduced into the French army during the Algerian War, 1844–7, and on the return of the army became a popular beverage in France. Much of the absinth is made in France and Switzerland. The effects of excessive absinthe drinking are believed to be much worse, on account of the nervous symptoms induced, than those produced by overindulgence in other alcoholic beverages. It is not allowed to be imported nor in interstate commerce in the United States.[1]

[1] F. I. D., No. 147.

"Anisette of Bordeaux" is a liqueur made in the south of France.

"Benedictine" is a liqueur originally made at Fécamp in northern France as early as 1510 by the Benedictine Monks of the Abbéy. It is a strong alcohol, flavored with various essential oils and herbes, however, the exact constituents are a trade secret.

"Chartreuse" is made at the Carthusian Abbéy near Grenoble, France, and also near Florence. Its manufacture furnishes a considerable revenue to the monks of these establishments. This liqueur is made from alcohol distilled with Angelica, hyssop, nutmeg, peppermint, etc., and heavily sweetened. Volatile oils and essences are at present largely used in its manufacture instead of the herbs and spices.

"Crême de Menthe," if genuine, is a liqueur made by distilling a fermented decoction of mint, sage, balm, cinnamon. orris, and ginger, sweetened with sugar and colored with chlorophyl. Much of this product now on the market is simply a tincture of the constituents, sweetened and colored with aniline dyes.

"Curaçao" is somewhat simpler than most beverages of this class. It is made chiefly in Holland, from the dried peel of the Curaçao (Dutch West Indies) bitter oranges. The peel is macerated and distilled with spirit, and sometimes flavored with a small quantity of Jamaica rum.

"Kümmel," although originally made from a fermented infusion of cumin and coriander seeds, sweetened with sugar, is now made with brandy, flavored and sweetened.[1]

"Maraschino," when genuine, is made from small, sour Dalmatian cherries (Marasca) crushed with the pits, mixed with honey, fermented, and distilled. The imitation is often made by the use of crushed wild cherries, peach pits, cherry leaves, orris root, etc., macerated with alcohol.

"Ratafia" is a general term applied to a variety of liqueurs

[1] Tibbles, loc. cit.

and cordials made in the south of France from fruits, spices, and herbs, fermented, distilled, and subsequently sweetened.

"Usquebaugh" is a highly alcoholic cordial made in Ireland from whiskey and other ingredients.

"Vetmouth" is made in France and in Turin, Italy, from a white wine which is "fortified" and flavored with various extracts and then exposed in casks for some time to the direct rays of the sun.

COMPOSITION OF LIQUORS AND CORDIALS

	Sp. grav.	Per cent.		
		Alc. by vol.	Extract	Cane sugar
Alcohol	0.816	94.9	....	....
Whiskey (Scotch)	....	50.3	....	....
Whiskey (Irish)	....	49.9	....	....
Rum	0.9378	51.4	1.260	....
Gin	....	47.8	....	....
Brandy	0.8987	69.5	0.645	....
Cider-brandy	....	64.0	0.110	....
Cherry-brandy (Kirschwasser)	....	51.0	....	....
Arrack	0.9158	60.5	0.082	....
Absinth	0.9116	58.93	0.318	....
Anisette	1.0847	42.00	34.82	34.44
Benedictine	1.0709	52.00	36.00	32.57
Chartreuse	1.0799	43.18	36.11	34.35
Crême de Menthe	1.0447	48.00	28.28	27.63
Curaçao	1.0300	55.00	28.60	28.50
Kümmel	1.0830	33.9	32.02	31.18
Ratafia	....	25.00	....	....
Vermouth	....	17.00	....	....

Mescal is the name of a distilled beverage made by the Apache Indians of New Mexico, and other natives in this vicinity, from a species of cactus (Maguey) having heavy succulent leaves and turnip like roots. After roasting, the product is "pulped" between rocks and the juice which exudes is allowed to ferment. This is the "lager beer" of Mexico, and is known as "**pulque.**" It is held that the injurious effects of this beverage are not so much due to the alcohol contained as to the other products of fermentation, expecially those of butyric fermentation, and to the yeasts, molds, etc., which are present. This beverage is fermented in the skins of hogs and cows, and is sold from these receptacles. It is a white thickish fluid, the taste for which must be acquired. Mescal-brandy is made by the distillation of this beverage.

Chica is the name of a beverage made by the Indians of Peru, and other South American countries, from the fermentation of corn (maize). A bunch of wheat or barley or a wreath of flowers tied to a pole in front of a hut indicates that this beverage is for sale within. They also make a very strong white rum called "*aguardiente*" by the distillation of fermented cane juice.[1]

Physiological Action of Alcohol

Since from the very earliest times alcoholic beverages have been used to excess, the physiological, medicinal and nutritive effects of alcohol have been very widely studied. The use of alcohol as a stimulant, as in medicine, it is not our province to discuss. For the reason that it is assumed to have nutritive qualities, its value in foods, or as a substitute for them, is of importance. Some beverages, such as wine and beer, have a slight food value from the sugar, or malted starch product, which they contain, but the distilled liquors have no such value.

In some of the more recent work carried on in the respiration calorimeter with a view of ascertaining whether alcohol acts as a food[2] a certain quantity of alcohol was given as a substitute for a calorimetrically equivalent quantity of sugar and starch. It was shown that the quantity of heat produced was identical, whether the subject used alcohol or its equivalent in sugar or starch in his diet. The influence of alcohol on work was also studied by converting the work performed into heat, and the amount of heat was the same, whether alcohol was substituted or not. Other experi-

[1] Nat. Geog. Mag., Vol. 24, p. 568.
[2] U. S. Dept. Agri. f. Ex. Sta. Bull. No. 69.

ments showed that the body tissues were slightly more used up with alcohol than with sugar.[1]

Although alcohol can, in some respects, be called a food, yet it is not a food of any practical importance, for it can merely replace a certain amount of fat, and perhaps of carbohydrates in the body, while its secondary effect on the nervous and vascular systems counteracts to a large extent the benefits derived from the production of heat and energy by its oxidation.

[1] Hutchinson, Food and Dietetics.

CHAPTER VI

ROOTS, TUBERS AND VEGETABLES

Next in importance to the cereals as a source of carbohydrates in our food, stand the vegetables. This term is often used to cover the large class of foods not cereals, that contain considerable starch and occasionally a little sugar. Here are included those very important plants which store starch for the nourishment of the growing shoot in their roots, tubers or underground stems; also those having young stalks that are used as food, and finally the leaves which, served either cooked or raw, add variety to the menu.

Wherever on the surface of the globe edible roots, tubers and cereals can be cultivated, there man has settled and improved the land. More arid or frigid sections are frequented by wild animals, and man is still obliged to live by fishing and hunting. Both North and South America afforded a good climate for the growth of the potato, the yam and the cassava, and the ease with which these starchy foods could be cultivated, exerted no doubt a considerable influence on the rapid settlement of these lands by European immigrants.

Composition

Vegetables in a fresh state contain from 70 to 95 per cent. of water, so there is not a very large margin for nutrients. For the sake of comparison the following table[1] of the amount of water in raw and in cooked vegetables is given:

The carbohydrates present in vegetables consist largely of starch with a small amount of sugar. The proteins are not abundant except in the legumes mentioned elsewhere. A considerable

[1] Jour. Chem. Soc., Vol. 61, p. 227.

WATER IN VEGETABLES

	Cooked	Raw
Potatoes	73.80	75.0
Tomato	94.07	89.8
Scarlet runners	91.12	91.8
Cabbage	97.45	89.0
Cucumbers	97.48	96.2
Mushrooms	97.97	90.0
Beet root	94.81	82.2
Radish	94.93	93.3
Lettuce	97.21	96.0
Celery	97.05	93.3
Salsify	87.29	....
Carrots	93.45	89.0
Cauliflower	96.46	90.9
Vegetable marrow	99.17	94.8
Spanish onions	98.69	....
Parsnips	97.28	82.0
Jerusalem artichokes	91.69	80.0
Haricot beans	73.62	74.0
Sea kale	97.95	93.3
Turnips	97.25	92.8
Spinach	98.07	90.0
Green peas	86.91	79.7
Broad beans	86.59	....

amount of the protein present in vegetables is not available as food material, as some of it is in the form of extractives and the value of the amides is till questioned. Fat is present only in small quantities.

Nutritive Value

Although the nutritive substances are not abundant in vegetables, they play an important part in the nourishment of the body. This is due to the attractive flavor of many vegetables, to their freshness and the variety which they add to the dietary, and perhaps, as one author has suggested, to the ionized condition of the solution of the mine-al salts contained in them; a condition in which they would be ready to take part in chemical reactions. When the water is evaporated from vegetables, as from potatoes for instance, so as to diminish the bulk, and concentrate the nutritive substances, the dried product, when moistened with water for use, does not seem to have the same flavor as does the fresh vegetable.

Many vegetables, especially the roots and tubers such as potatoes, beets, turnips and carrots, and some of the more succulent plants like the cabbage, may be stored in the cellar for winter use while asparagus, rhubarb, and spinach are preserved by canning.

POTATOES (Solanum tuberosum)

The potato is a member of the Solanum or Nightshade family to which belong tobacco, henbane and belladonna, as well as the tomato, Jerusalem cherry and egg plant.

As a source of starch, the potato stands next to corn in the United States, and above it in Europe. As a vegetable it is above the average in nutritive value, and is deservedly most popular. The extensive use that is made of the potato is shown by the fact of its increasing production. In the United States in 1911 over 292,000,000 bushels of potatoes were raised. This is in quantity far ahead of any other vegetable produced. Although the potato contains less than 25 per cent. of nutritive material there are many other considerations which make it an extremely valuable food.

History

The potato is a native of Chili, Peru and Mexico. It is a "much traveled" tuber, as it was probably taken from Peru to Spain early in the sixteenth century, and to Florida and Virginia by the Spanish explorers, then to Great Britain from Virginia about 1565. The wild plant is still found in South America, but with a less developed tuber. It was cultivated in Europe, and in 1663 recommended by the Royal Society of London, on account of its great yield, for introduction into Ireland as a safeguard against famine. This, however, proved to be a false hope, as later too much reliance was placed in the potato by the Irish, and when a potato disease made the crop a failure in 1846 great suffering resulted.

For many years the potato was extensively cultivated in Virginia, but was only introduced into New England when carried there from Ireland in the eighteenth century. As late as 1771 it was regarded in England as valuable only as food for stock.

Structure

The potato is really a modified stem, which is thickened to serve as a receptacle for the starch needed for the propagation of the young plant. By making a cross section, it will be seen that the potato consists of four portions as follows: First the skin; second the cortex; third the fibro-vascular layer; fourth the flesh, which is made up of two medullary layers.

In the cortex layer, which constitutes but 8.5 per cent. of the weight, is found nearly all the coloring matter of the potato. This is the part which turns green and acquires a bitter taste when the tubers are exposed to sunlight. This is the portion usually removed when potatoes are peeled, and as it is richer in protein and mineral salts than the other portions of the potato, the parings should be thin. The fibro-vascular layer contains some woody tissue, but this is much less abundant than in our other vegetables. The reason for this is that the potato is a side branch, and not on the direct line between the root and the leaves, so there is little development of woody tissue.

Cultivation

Potatoes are propagated from the eyes of the tubers, as the seeds cannot be depended on to produce the same variety as the parent plant. They can be planted quite early, but the sprouts should not be much above the ground while there is danger from frost. They grow best in a loose, somewhat sandy soil and do not thrive in a hard, clayey soil.

Storage

Although well adapted for storage and transportation, it is important to remember that potatoes will not keep well in a warm place, or where there is much light. They are best stored in a cave cellar where the temperature does not go below 35° F., or in piles, or pits out of doors, covered with straw, earth and manure. The loss in weight by storage during the winter is about 11 per cent., and is mostly due to the evaporation of water. The enzymes of the cells will during this time induce marked changes, as the sugar is broken down and carbon dioxide and water are given off. Some of the insoluble starch is also changed to dextrin and other substances, so the flavor is decidedly different as spring approaches. Potatoes that have been exposed to the light and have turned green, and also sprouted potatoes, contain more of the characteristic active principle "Solanin" ($C_{42}H_{75}NO_{12}$) than do normal potatoes, and have sometimes produced symptoms of poisoning. Some object to the use of the water in which potatoes have been boiled for making bread or soup on the ground that it is poisonous from its solanin content, while others assert that this substance is eliminated by cooking.[1]

Composition

In the edible portion of the potato there is 78.3 per cent. water, 2.2 per cent. protein or nitrogenous matter, 0.1 per cent. fat and 18.4 per cent. carbohydrates—mostly starch, with 1.5 per cent. of fermentable sugar and 1 per cent. of mineral matter. Potash is the most characteristic of the mineral ingredients, so that the potato is one of the important sources of this substance in

[1] Food and Dietics, Hutchinson, p. 229.

our diet. Practically only about one-fifth of the potato has nutritive value. There is only one-half of 1 per cent. of cellulose; not enough to in any way interfere with digestion. In the young potatoes there is a larger proportion of sugar, than when they become mature; and as they lie in the ground there is an increase in the starch. During the process of sprouting some of this starch is changed by a ferment into soluble glucose.

Only about 60 per cent. of the protein present is true protein: that is of a character such as can be used to build and repair the tissues.[1] These proteins[2] consist of a globulin, called "tuberin" and a proteose, and are most abundant in the outer part of the tuber.

Nutritive Value

Comparisons are sometimes made between potatoes and cereals such as rice. As purchased, the potato contains only about 20 per cent. of nutritive matter, while rice contains 88 per cent. To prepare rice for eating, water must be added to it, so if we compare 4 pounds of potatoes with 1 pound of dry rice, we shall find that the two contain about the same quantity of nutritive material. Four pounds of potatoes cost from 3 1/2 to 10 cents, while a pound of rice costs from 4 to 7 cents, so there is not such a great advantage in cost in favor of rice.

Another point of importance in comparing the dietetic value of rice and potatoes is that the rice leaves the blood acid and the potato alkaline. On this account potatoes are better combined with meat and eggs, which leave acid residues in the blood, and rice with legumes, other vegetables and milk, which all leave alkaline residues. The potato contains but little iron, calcium and phosphorus, the elements too often lacking in the food of children, so it should be supplemented by other vegetables, eggs and milk.

Just as apples turn yellowish when peeled and exposed to the air, so potatoes turn brown under the same conditions. The

[1] J. Am. Chem. Soc., 18, p. 575.
[2] Ct. Agri. Exp. Sta.

unorganized ferments in the potato, act on certain substances allied to tannin and change the color. This is especially noticeable when grated potatoes are allowed to stand for some time, as in the preparation of starch. (See p. 58.) By protecting the peeled potatoes from the air, with water this discoloration can be largely avoided.

Cooking

In the process of cooking it has been found[1] that the middle lamella which holds the cells together is dissolved, and the cells are separated from each other, but the cell walls are not broken.

If, however, saliva is added to the unbroken cells, the starch which they contain, which has been swollen by the cooking, is quickly digested, the cooked cell walls being easily permeable. Some starch grains are also changed by heat to a soluble form of dextrin, and the protein is coagulated, while mineral salts are but little affected. A "mealy" well-cooked potato is in the proper physical condition to be readily acted on by the digestive fluids. Cooking improves the taste of the potato, as from the continued use of cooked starch we have learned to prefer it to raw starch.

From numerous tests that have been made at Agricultural Experiment Stations, in the various States[2] it is shown that while only 8.2 per cent. of the protein is lost when the potatoes are plunged directly into boiling water, if they are soaked for several hours before cooking about 25 per cent. is wasted and if plunged into cold water which is then brought to a boil 15.8 per cent. of the protein is lost.

The above tests were made with peeled potatoes, but when boiled with their "jackets" on, the loss was only 1 per cent. of the protein, and a little over 3 per cent. of ash, by either process of cooking. Nutritive material is therefore saved if potatoes are boiled in their jackets. Some suggest to remove a section of the skin at each end to allow the moisture to escape. As soon as the

[1] Jour. Home Economics (1909), No. 2, p. 177.
[2] U. S. Dept. Agri. Bull. No. 43.

potato is cooked it should be taken from the water to prevent it becoming "water soaked," or boiled, to pieces. It should be noted that the temperature of the interior of the potato in the boiling process, is several degrees below 212° F.

In baking potatoes very little nutriment is lost. The starch is thoroughly cooked as the temperature attained in baking is several degrees above the boiling point. Unless they are to be eaten immediately it is advisable to break open as soon as done to allow the steam to escape, so that the tuber may not become "soggy" on standing then keep in a warm place covered with a clean towel or napkin to absorb the steam. If put into a covered porcelain dish the steam is condensed and falls back on the potato.

Potato chips, cut in thin slices, absorb as much as 39.8 per cent. fat, and the heat to which they have been exposed (which is above the temperature of boiling water) has driven off all except 2 per cent. of the moisture. Fried potatoes are more thoroughly cooked if boiled before frying.

Besides mealy potatoes, which are prepared from well-developed tubers, not too long stored "waxy" potatoes since they hold their shape better are much in favor, especially for salad and fancy dishes.

Dried Potatoes

Desiccated potatoes, which are prepared by grating and drying at not too high a temperature, contain about the same constituents as the fresh potatoes minus the water, or 8.5 per cent. of protein and 81 per cent. of carbohydrates. They are extremely useful for camping parties, or at sea, or whenever it is impractical to transport fresh potatoes. The process of bleaching by the use of chemicals as applied to this class of goods, is to be regarded in the light of an aduleration, and should not be encouraged. Canned potatoes may also be found convenient under certain circumstances. Potato flour has been much used in Germany.

In the mountains of Peru, where potatoes were grown long before they were introduced among civilized people, the Indians prepare a product called "*chuñu*" by allowing potatoes to freeze in piles on the ground, and treading out the juice with the feet the next morning. Prepared in this way the potatoes keep well but lose much of their flavor. The chuñu, which is a dry material, is usually ground in a stone mortar and used in the form of powder to thicken soup.[1]

Potatoes as Food

Potatoes are by no means a perfect diet, in fact they are not as satisfactory as bread if one would live on a single food. As ordinarily used, with meat, milk, eggs—and other foods containing fat and an abundance of protein, they are extremely valuable. They came into general use, after they were introduced, on account of their agreeable taste, abundant yield, superior keeping qualities and ease of propagation. They are valuable because they neutralize the acids of the blood and thus prevent diseases such as scurvy, to which those are liable who are obliged to subsist mainly on salted meats. Potatoes therefore rank next to breadstuffs in Europe and America, as a source of carbohydrates, and as one of the cheapest antiscorbutics.

The Yield of Potatoes

The potato grows well in England, Ireland, Scotland, and the north of Europe; in fact it is successfully grown up to 60° north latitude in Sweden. In the United States it is grown most abundantly in New England, New York, Pennsylvania, Ohio, Michigan and Wisconsin. They are raised as an irrigated crop in Colorado and California. In the South they are raised mainly as an early crop for the spring market. They are also an important crop in Canada.

The potato crop of Europe is of more importance than that of the United States. In 1910 Germany raised 1,597,000,000 bushels, France 313,000,000 bushels, Austria-Hungary 690,000,000

[1] Nat. Geog. Mag., Vol. 24, p. 568. Com. Rep., 1915, p. 1420.

bushels, Great Britain and Ireland 236,000,000 bushels, and the previous year Russia (European) raised 1,173,000,000 bushels. In 1912; 420,647,000 bushels of potatoes were raised in the United States, and 2,500,000 bushels were imported from foreign countries.

Small and inferior potatoes are used for the manufacture of alcohol, especially in France and Germany. In this process, after washing the potatoes and grinding to a pulp, the mass when mixed with water is run through a sieve, and the starch is allowed to settle out. The wet starch is treated with acid in the proportion of one of acid to ten of pulp. The glucose thus prepared is put into vats and fermented with yeast for fifteen to twenty days. It is then distilled in an ordinary whiskey still, to produce "low wines" and redistilled for a more concentrated spirit. More care is required to prevent the alcohol from potatoes being contaminated with fused oil than if the alcohol is made from grains.

For the manufacture of starch from potatoes see under "Starch" p. 58.

There is a growing demand in the United States for *potato flour* to use especially in the manufacture of starch. Nearly $300,000 worth of this material was sent here from Holland in 1912.

CASSAVA (Tapioca) (Euphorbiaceæ.)

The cassava, on account of its starchy root, is extensively used for human food as well as for feeding live stock and for the manufacture of starch. It grows readily in the tropics. There are two principal varieties—the "bitter" cassava (Manihot utilissima, Pohl) and the "sweet" cassava (Manihot aipi, Pohl). The plant which is a bushy shrub from 4 to 10 feet high, is propagated by means of cuttings about 6 inches in length.[1] In the southern United States they may be stored during the winter for spring planting.[2] The roots, which contain the starch grow in clusters

[1] Cassava, U. S. Dept. Agri. Farmers' Bull. No. 167.
[2] Manufacture of Starch from Potatoes and Cassava, Bur. of Chem.

often 2 inches in diameter and 4 feet long, with a weight of from 10 to 30 pounds.

Cassava has been most extensively grown in India, South and Central America, Africa, and the West Indies. In the United States cassava may be successfully grown in the southern part of the states of South Carolina, Georgia, Alabama, Mississippi, Louisiana and Texas and in all of Florida. This area is thus limited by the frosts of more northern latitudes, as at least eight months free from frost is needed for the growth of a successful crop.

The sweet cassava does not contain enough prussic acid (HCN) to be dangerous, while the bitter cassava contains enough of this poisonous substance to make it unsafe to use without special preparation. The sweet variety has been found to contain not more than 0.01 per cent. of hydrocyanic acid (HCN), while the bitter varieties contain from 0.02 to 0.77 per cent. As the root of the bitter cassava is liable to be poisonous it is used as food for man only in the countries where it grows. The cassava is of American origin, and has been used for centuries as food by the South American Indians, who peel and cook all varieties.[1] The juice extracted from the pulp of the bitter cassava yields a substance known as cassareep,[2] which is used in making up the flavor of Worcestershire and other sauces. (See p. 440.) This juice is boiled down and the prussic acid is in this way eliminated.

There seems to be no fixed standard by which the sweet varieties can be distinguished from the bitter, and it is in fact quite probable that cultivation or change of climate may cause the hydrocyanic acid content to vary.

The composition of tapioca, the form in which we know cassava starch, is, however, of more importance.[3] This food is extremely rich in starch, of which it often contains 85 per cent. It is poor in protein and other nutrients.

[1] Cassava, U. S. Dept. Agri. Bur. of Chem., 28, 44 and 106, Bull. No. 58.
[2] Food Products of the World, Green, p. 200.
[3] Mandioca of Brazil, Com. Reports, 1915, p. 232–236.

Tapioca as Food

In Liberia, the national dish of the natives is "dumboy," which is prepared from the cassava. The roots are boiled, the central fibers removed, and then the mass is beaten in a wooden mortar with a heavy pestle. This operation which takes about three-quarters of an hour, is very laborious, and requires considerable skill, as the operation must cease at just the right time. The dumboy is eaten with a soup having as a basis some kind of meat, and in which a variety of vegetables is used. It is said that a taste must be cultivated for this dish, but that when this is once acquired the food is more and more enjoyed. In Sierra Leone a dish called "fou fou," which is entirely different from "dumboy" in taste and appearance, is prepared from the cassava.[1]

Authorities differ somewhat as to the digestibility of tapioca. Thompson[2] believes that since the granules are not tough and are easily digested, tapioca forms one of the most useful amylaceous foods for persons with feeble digestion. Hutchinson[3] argues that since tapioca remains in the stomach for some time during the process of digestion its use should be avoided when it is desirable to lighten the labors of the stomach.

The flour made from tapioca is in some countries used for making a bread, which replaces wheat bread. It contains 9 per cent. of protein and 79 per cent. of starch and sugar, and so compares favorably with wheat. By fermentation of the starch, an alcoholic beverage is prepared. Raw cassava paste is used as a healing ointment in Jamaica.

To store the cassava roots, they must be kept warm and dry. They are, however, usually worked up into food products immediately, unless intended for stock food.

Manufacture of Commercial Tapioca

To prepare the tapioca, of commerce, the root is grated or ground with water, the cellulose and unground portions separated

[1] National Geographic Magazine, Vol. 22, p. 84.
[2] Practical Dietetics, p. 157.
[3] Food and Dietetics, p. 236.

by filtration through cloth and the liquid is then allowed to stand at rest for a time to deposit the starch. While the starch is still moist, it is gradually heated until the starch granules are to some extent ruptured and the mass is agglutinated and rather firm. The heat is continued until the moisture is nearly all expelled. This completes the expulsion of the hydrocyanic acid. By subsequent operations the tapioca of commerce is prepared for the market as "pearl" tapioca "flake" tapioca and tapioca "flour."

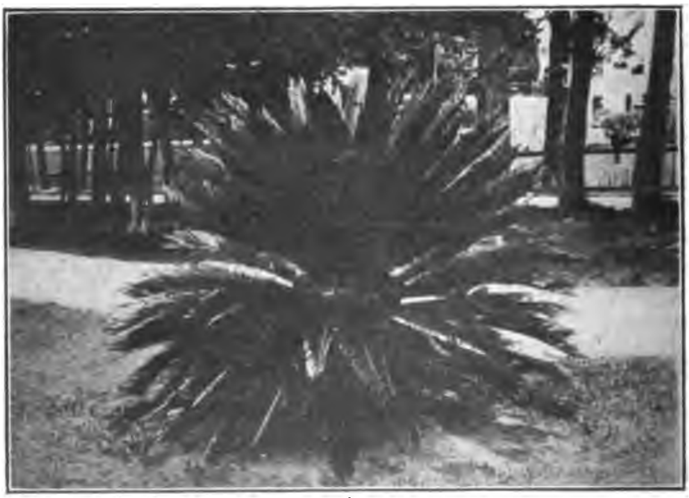

FIG. 23.—A sago palm, Bermuda. (By permission, Central Scientific Co.

The amount of starch in the fresh root of the cassava or *manihot* as it is called in many countries, varies with the variety. Some of the samples grown in Florida contained 25 per cent. of starch, or somewhat more than potatoes. An artificial product made from potato starch is sometimes sold for tapioca.

Mandioca may almost be called the national food of the people of Brazil.

The amount of sago and tapioca imported into the United States in 1912 was valued at $7,684,725.

SAGO (Metroxylon Rumphii)

This starchy food is made from the pith of the sago palm, of which several varieties, grow in the East Indies, China, Japan, southern Asia, Siam and the Philippine Islands. (Fig. 23.) The trunk of the tree is filled with the starchy pith, which is most abundant, just before the blossom appears. This, however, does not happen until the tree is twelve or fifteen years old.

Manufacture of Commercial Sago

To obtain the starch from the tree, the trunk is cut into lengths of 5 or 6 feet, which are split lengthwise. The pith, which is of a cheesy consistency is scraped out, mixed with water and reduced to a pulp, by grinding in a crude mortar, and then strained through a sieve to separate the coarser particles and the cellulose. The starch, which is allowed to settle out, is washed several times, and dried, and thus prepared constitutes the "sago flour" of commerce.

In making "pearl sago," this flour is mixed with water and granulated by passing through a sieve, then roasted once or twice which makes it translucent in appearance. It is then assorted by sifting, into various sizes. A single palm tree will often yield 500 pounds of sago starch.

This starch is used (mixed with milk, butter, eggs and sugar) mainly for making puddings; a combination which gives a well-balanced ration. In some parts of the world sago flour is the standard food of the inhabitants, comparable only to wheat in importance.

ARROWROOT (Canna indica)

(Canna edulis) (Tacca primatafidia) (Maranta arundinacea)

There are several plants grown in different tropical countries that furnish the starchy food known as "arrowroot." They are a native of both the East and West Indies. The starch grains from the different varieties have a general similarity when viewed under the microscope. The name is said by some to be derived from the peculiar saggitate character of the rhizome or root stalk of some varieties; others ascribe the name to the fact that a poultice made from the rhizome was used by the natives in the treatment of arrow poisoning.

The starch known as "Tous les Mois" is made from the Canna edulis grown in the West Indies. It has very large starch grains. The Bermuda arrowroot (Maranta arundinacea) is also extensively grown in the West Indies. Madagascar arrowroot (Tacca primatifidia) is grown on the island of that name, and also in Otaheite.

Commercial Arrowroot

In the process of manufacture of this starch[1] (for such it really is) from the rhizome or root stock which may be cultivated like the potato—the root is washed, peeled, ground or grated to a pulp and strained through cloth. The peelings contain a resinous bitter substance. The milky liquid is strained into a settling tank through a perforated cylinder and allowed to stand until the starch settles out. The liquid is then run off and the moist starch is dried in the sun in flat copper pans or on wooden trays with cloth bottoms, covered with gauze.[2] This starch is packed in new barrels, lined with peper stuck in by arrowroot paste, as great precautions are necessary to prevent its acquiring a flavor from the outside. This starch is quite similar in appearance to any other starch, and has an insipid taste, unless flavored with sugar and other substances The commercial product contains 82.5 per cent. of starch, but is, of course, low in protein and mineral matter. Canna starch may be made by a similar process to that described for arrowroot.

Use of Arrowroot

As a bland food for invalids arrowroot is especially recommended on account of its ready digestibility. When made into a

[1] J. Soc. Chem. Ind., Vol. 21, p. 420.
[2] Food and Dietetics, Hutchinson, p. 236.

jelly it keeps longer without fermentation than any other of the starches, so it is often prescribed in cases of dyspepsia.

Arrowroot lends itself readily to adulteration with other starches, especially that of the potato, and only by the use of the microscope can this fraud be detected. In those countries where it grows with little cultivation, viz., Jamaica, Bermuda, East Indies, Australia, South Africa and Madagascar, arrowroot is a very important article of food.

ARTICHOKE (Jerusalem)

(Helianthus tuberosus)

This tuber of the sunflower family, is indigenous to Canada and the northern United States. The name "Jerusalem" is a corruption of the Italian *girasol*, meaning sunflower. It was introduced into Europe in 1616. Although grown on the Continent it has never been extensively cultivated either in the United States or England, perhaps on account of its rather strong flavor. This tuber (Fig. 24) has been found to contain 14.7 per cent. of sugar and no starch, but it contains considerable inulin, a substance isomeric with starch. It is not injured by moderately cold weather, so in many localities may be allowed to remain in the ground during the winter. A variety known as "Crosnes" is grown in China and Japan. (See Artichoke, p. 183.)

Fig. 24.—Jerusalem artichoke.

ASPARAGUS (Asparagus officinalis)

This plant was known and prized as food by epicures from the earliest Roman times. More than four hundred years ago it was grown and relished in nearly every part of Europe, and was early introduced into the United States.[1] One variety at least is a native of Great Britain and grows wild in the fens of Lincolnshire and the seacoast of Cornwall. It can be readily raised in any well-drained fertile soil throughout the temperate zone; in the United States it grows as far south as Charleston, S. C.

Asparagus is propagated by setting out the one-year-old "crowns" or plants, or by sowing the seed. A bed once started, and kept well manured will continue to produce an abundance of "spears" or stalks for fifteen or twenty years. It is of great importance in growing asparagus, that the bed have an abundance of sunshine throughout the entire day.

In preparing the young shoots for the table they are thrown into boiling water previously salted, and boiled for about twenty minutes—the time of cooking being dependent on whether they are tender or old and wilted. If cooked in this way the water in which the asparagus is boiled should be concentrated, and used in making a sauce, thus retaining the flavor and the nutrients. The best flavor is obtained if asparagus is cooked within twelve hours after being cut. If allowed to wilt, or become stale, as is often the case before it reaches the consumer, the flavor is injured. Asparagus served with a thickened dressing on toast is an extremely appetizing and wholesome dish.

Composition of Asparagus

This plant contains 0.4 per cent. of a peculiar crystalline amid principle, called "asparagin" ($C_4H_8N_2O_3$) (also found in the potato) which has aperient and diuretic properties. It is also believed to act a useful part in the intestine by limiting putrefaction, and so sparing proteins from destruction.[2] Within a very short time after asparagus is eaten, it will be found that the excretion of the kidneys possesses a strong, disagreeable odor. This is caused[3] by a volatile sulfur product called methyl mercap-

[1] U. S. Dept. Agri. Farmers' Bull. No. 61.
[2] Food and Dietetics, Hutchinson, p. 233.
[3] Practical Dietetics, Thompson p. 172.

tan, which originates in the intestines during digestion, and is afterward excreted.

The food value of asparagus is low, as it contains about 94 per cent. of water. It should be said, however, that the edible portion contains more protein than most roots and succulent vegetables. On account of its delicate flavor, its appearance in the early spring, and its ready digestibility, asparagus is much esteemed, and is every year more extensively grown in the United States. A small unbleached variety is often grown in Europe. Fennel stalks, hop sprouts, and bamboo shoots are used in some countries in the same way as asparagus.

BEETS (Beta vulgaris)

The ordinary garden beet, which belongs to the order of Chenopodiacæ, is important as a source of food, while the sugar beet (see p. 105) is interesting as an example of what can be done by the cultivation of a root in raising the per cent. of sugar.

We know that beets have been in common use, at least on the Continent, since the beginning of the Christian era; and that they were later introduced into England and America. The red and the yellow varieties are particularly in favor as garden vegetables, while white beets are used for sugar manufacture.

Beets as Food

The beet when tender makes an excellent addition to the variety of vegetable foods. When young the entire plant, including the root, is boiled for "greens." Considered as a vegetable, the garden beet contains about 12 per cent. of solid matter, which is somewhat low in protein while the sugar, starch, etc., amount to about 8 per cent. Of the total nitrogenous matter only a small fraction is protein, the greater portion being nitrates, etc. Beets are often served with vinegar which assists in softening the fiber, and does not interfere with the digestion of other constituents.[1]

[1] Foods and Dietetics, Hutchinson, p. 235.

Cooking Beets

Even more than other vegetables, beets lose a large per cent. of their nutritive material on boiling, since such a large portion is soluble in water. This loss can be reduced somewhat by being careful not to break the skin, and especially not to cut off the root ends and the leaf stalks close to the root. The loss may be further diminished, as in the case of other vegetables, by steaming instead of boiling.

The beet is grown readily for domestic use throughout a wide latitude from the tropics to the north, but the belt in which a high sugar content may be produced is comparatively narrow. (See Sugar Beet, p. 105.) The *mangel-wurtzel* is very similar to the sugar beet, and is grown mostly for cattle food.

CABBAGE (Brassica oleracea L.)

There are numerous plants of this family, the Cruciferæ, that are used as food, largely, no doubt, on account of their agreeable flavor and their succulent character. They are also important because of their antiscorbutic or scurvy preventing action. They seem to have been evolved by natural or artificial selection from the wild "coleworts," or "collards," that grow on the seashore in many countries. This plant was probably first cultivated by the Germans or early Saxons, and was in common use in Greece and Rome in early times. Its acceptance was rather slow in Great Britain, but when once introduced it soon became a favorite food, especially with the Scotch and Irish. The leaves rising from the root stalk are gathered together to form a compact head, and as, in this way, the light is excluded they become white from lack of chloryphyl, and are crisp and tender. Young plants, grown in a hot bed, are set out in the early spring.

Composition

Of course, cabbage leaves cannot have a high nutritive value, as they contain 91 per cent. of water, but there is some sugar and starch present, and another valuable constituent is the protein, which is proportionately rather high. The value of the calcium compounds should not be overlooked, as they probably give the cabbage antiscorbutic and bone-building properties. Cabbages contain some sulfur compounds, so that the water in which they are boiled has a disagreeable odor, and the volatile substance given off with the steam produces a characteristic persistent odor. The cabbage, although not easy of digestion, is valuable as a varient in the food, but its use should be avoided by invalids, as it is liable to produce flatulence and indigestion.

Cooking Cabbage

Cabbage is eaten boiled or raw. After cooking it contains 97.5 per cent. of water. Since the water in which cabbage is boiled cannot be used as food, it is better that it be either steamed or eaten raw, so that the nutrients shall not be lost. The Scotch have a dish called Kale-brose and the Irish prepare what is known as "Kolcannon," by cooking together salt pork, potatoes, and cabbage. The "boiled dish" of the United States usually contains cabbage as a necessary constituent. Vinegar is often used with either raw or cooked cabbage and probably assists digestion in that it helps to dissolve the abundant cellulose. Savoy cabbage is the name applied to numerous varieties which have crimped or curled leaves.

Sauerkraut

The principal method of preserving cabbage is in the form of sauerkraut, originally a German dish, but now extensively used in the United States. In this process, which is in fact a kind of ensilage applied to human food, the cabbage is packed in casks with salt, and the mass is pressed so that some of the juice is squeezed out. After standing for some time a kind of fermentation takes place in the cabbage and various organic acids are developed which impart to the product a flavor much prized by those who have a taste for it.

One of the characteristic national dishes of Russia called "sktshi" is made by packing chopped or sliced cabbage into barrels with vinegar and salt, and allowing it to ferment. This is made into a broth with meat and forms an important part of the daily food.

Cauliflower

The cauliflower is a variety of cabbage much more delicate in flavor and more digestible than the ordinary cabbage. The edible portion consists of the inflorescence altered by cultivation. It was first grown in Italy and was introduced into England from the continent early in the seventeenth century. Brussels sprouts is a variety of cabbage having blistered leaves and the stem of the plant covered with small heads of cabbage, which are the edible portion of the plant.

CARROT (Daucus carota)

The carrot(along with celery, parsnip and parsley) belongs to the natural order Umbelliferæ, and like them contains an essential oil that gives it a strong characteristic flavor. It has been modified from the "wild carrot" by cultivation. Carrots are common all over Europe and western Asia where they have been cultivated for 2,000 years. It is said that during the reign of Elizabeth[1] the cultivated root was introduced into England. It has been modified from the wild variety so that it is now a thick succulent yellowish red root. It is in more common use in Europe than in the United States, and like many strong flavored plants seems to be liked only by those who have cultivated a taste for it.

When the foliage is wet, wild carrots give off a poisonous substance, perhaps an oil which produces an eczema similar to that produced by poison ivy (Rhus toxicodendron L.).

Composition

Carrots are somewhat richer in nutrient matter than turnips as they contain nearly 12 per cent. of solid matter. About half

[1] Food, A. H. Church, p. 1 3.

of this is sugar (sucrose and levulose). The outer layer contains considerable pectose. About 30 per cent. of the nutrients is dissolved out when carrots are boiled in a relatively large quantiy of water.[1] This root also contains a peculiar ruby red crystalline substance, without taste or smell, called "carotin."

Carrots are grown quite extensively as a cattle food, while their value as food for man depends on the agreeable variety which they give to the diet, and the fact that with the small per cent. of nutrients they contain inert vegetable matters which aid in the process of digestion. The young and tender roots are a better food than the old, as they have a tendency to become woody with age. The root is cut, dried and roasted, and used as a substitute for coffee in some parts of Germany.

OKRA or GUMBO (Hibiscus esculentus)

This plant[2] belongs to the natural order Malvaceæ. There seems to be quite convincing testimony that the original home of the okra is Africa, for it was cultivated by the Egyptians as early as 1216 A. D., and has been for many years in common use in Turkey, northern Africa, and around the Mediterranean Sea. Its Spanish name is gumbo. In appearance it is much like the cotton plant, and the young pods used especially for flavoring soup are the edible portion. It is grown from the seed, planted in rows or in hills like corn. In order to preserve the okra for use throughout the year a special variety, known as *petite gumbo* is grown, strung on strings and dried; when larger varieties are to be dried, they are first cut into slices crosswise, and then strung.

Cooking

No copper, brass or iron cooking vessels should be used in cooking okra, as these discolor the pods. The green pods are often stewed and served like asparagus. Although containing only

[1] U. S. Dept. Agri. Office. Exp't. Sta. Bull. No. 43.
[2] U. S. Dept. Agri., Farmers' Bull. No 232.

about 8.5 per cent. of nutriment, including starch, sugar and proteins, this vegetable has come into favor, especially with the Creole cooks of the southern United States; and their "chicken gumbo" has long been a favorite dish. Not only is the soup flavored by the use of this pod, but a mucilaginous consistency is imparted to the product.

ONION (Allium cepa L.)

This plant of the lily family, although possessed of a strong odor, which to many is disagreeable, is very highly valued, especially for the flavor which it imparts to other foods. Garlic, shallots, leeks and chives are other condimental foods of the same kind. The use of the onion dates back to the earliest ages of authentic history. Its original home was probably in southern Asia or in the countries surrounding the Mediterranean Sea.[1]

It is said that the onion was worshiped in Egypt before the Christian era, and it was used in the ancient Druidic worship in Great Britain. It is readily grown from the seed, or "onion sets" grown the previous year may be planted. The entire plant of the young onion is often eaten. A peculiarity of some plants, like onions and asparagus, is that they grow readily in soil containing considerable common salt. They are also grown best where there is an abundance of moisture. Onions to be stored should be dry and thoroughly cured. They are often cured by standing in bags in the field. They require a low temperature (just above freezing) and a dry air, with good ventilation in order to keep well.

Composition

Plants of the *allium* family are peculiar in containing an acrid volatile oil (allyl sulfide) ($C_6H_{12}S_2$) to which many of the characteristic properties are due. They contain from 10 to 15 per cent. of nutrients, including dextrose and levulose, and a small amount of protein. Garlic is especially rich in a peculiar mucilage.

[1] U. S. Dept. Agri., Farmers' Bull. No. 354.

Onions may be cultivated over large areas in temperate and even tropical climates. The bulbs grown in the southern countries, as in Spain and Portugal, are imported to Great Britain, and those grown in Bermuda to the United States, and are considered as of more delicate flavor than those grown farther north.

In the United States the onion holds the third place among truck crops.[1] In 1908, 14,000,000 bushels, valued at $10,000,000, were grown and consumed here.

GARLIC (Allium sativum)

This is the most strongly flavored of the plants of the allium family. It is extensively grown and much esteemed in southern Europe. The strong odor which the plant possesses is readily communicated to the breath and even to the perspiration of the consumer. Garlic is used more as a condiment for seasoning other foods than as a vegetable alone. It has a medicinal action, quickening the circulation, and exciting the nervous system. *Shallot* has a similar medicinal action upon the system. *Chives* another plant of this family which has small slender leaves is used for making pickles and salads in Europe, and to some extent in the United States.

PARSNIP (Pastinaca sativa)

The parsnip belongs to the same family as the carrot and like the latter has been cultivated sincc the time of the Romans. As the root of the parsnip is not injured by the frost, it may be left in the ground all winter. It is usually grown in a single season and the smaller roots are more tender and better suited for human food, while the larger and more woody roots are excellent as a cattle food.

Composition

The parsnip contains considerable nutritive material of the sugar-starch group, and about 80 per cent. of water. It is unique in containing more fat than other vegetables of this class, viz.,

[1] U. S. Dept. Agri., Farmers' Bull. No. 354.

0.66 per cent. It is therefore a somewhat better food than the turnip and the carrot. Pectose and cellulose are found to quite a large extent, but there is only 1.3 per cent. of protein present. The parsnip has such a strong flavor that it is not liked by all persons. On account of containing from 13 to 14 per cent. of carbohydrates, a wine of excellent flavor is made from the juice of the parsnip in Great Britain and the fermented and distilled juice yields a potable spirit.

RHUBARB (Rheum raponticum)

This plant, which belongs to the Buckwheat family, often called "pieplant" or "wine plant," is used in the spring for making pies and sauce. The thick petioles or leaf stalks are utilized for this purpose. The plant, although indigenous in portions of Asia, is said to have been brought originally from the vicinity of the Volga River and was first grown in England in 1573. In Germany it is cultivated both as an ornamental plant, and for food purposes. The plant is readily grown as it is a perennial, so that the roots once started annually produce an abundant crop.

Composition

Although the stem contains considerable fiber, it is made soft by cooking. It contains a large amount of acid potassium oxalate and acid calcium oxalate, and on this account requires an abundance of sugar to make it palatable. As the rhubarb contains from 92 to 95 per cent. of water, its nutritive value is not usually considered, although it is interesting as containing 1.19 per cent. of fat,[1] which is more than is ordinarily found in vegetables of this class, and 2 per cent. of sugar.

The rhubarb has some medicinal qualities, and acts slightly as a laxative. In case there is a tendency to certain diseases such as gout and rheumatism, this plant should not be used as food.

[1] Foods and Their Adulterations, Wiley, p. 299.

It should be noted that the plants Rheum officinale and R. polmatum, the rhizomes of which are used in medicine under the name rhubarb, belong to the same family.

Besides its use as food, rhubarb is of value for making a wine which has a characteristic flavor highly appreciated. For this purpose it is only necessary to express the juice, add sugar, and allow it to ferment.

SALEP (Orchis masculata)

The salep, which grows abundantly in the Orient, is a tuberous root of the Orchid family. The root contains considerable of the mucilage known as "bassorin," and some starch, and may be used for making mucilaginous drinks. It is prepared for food by being heated, then dried in the sun, and when needed immersed in boiling water, or crushed to powder, and boiled with milk to form a kind of jellied pudding.

SALSIFY (Tragopogon porrifolius)

The salsify, or "Oyster Plant," has an edible root, something like the carrot in appearance which grows wild in the south of Europe and in Algeria, and is also cultivated. When not too old the roots have when cooked a delicate flavor which suggests oysters. They may be cooked and served with sauce in the same way as asparagus.

SWEET POTATOES (Ipomea batatas)

This plant belongs to the order Convolvulus (Morning Glory) and is probably a native of tropical America,[1] although it was known in England before the introduction of the Irish potato. The sweet potato grows best in a climate where there are at least four and one-half months without frost, and in moderately fertile, sandy loam. When grown near the northern limit of latitude,

[1] U. S. Dept. Agri., Farmers' Bull. Nos. 129, 295, 234, 419.

where the nights are cold, it is not as sweet nor of as fine flavor. The commercial crop is grown mostly from cuttings started in a bed or from the potatoes cut in pieces as with white potatoes. The portion used as food and which is in reality an enlarged root (stock) may be referred to as a tuberous root. As ordinarily planted, the vines cover the whole surface of the ground.

Sweet potatoes do not keep as well as the ordinary variety, and they are also subject to various diseases. For keeping they require a warm dry atmosphere, therefore they are best kept in the North under conditions similar to that of a rather cool dwelling and in the South in pits or out-of-door cellars, which must be well ventilated.[1] They keep best in a room where the fluctuation in temperature is not over 50 either way from 54° F.

Composition

The sweet potato contains from 4 to 6 per cent. of sugar and usually over 20 per cent. of starch. Most of the sugar is sucrose; but there is an appreciable amount of non-crystallizable sugar. The quantity of sugar increases and the quantity of starch diminishes on storing, just as is the case with some fruits.

On account of its composition, the sweet potato is not so readily cooked so as to be "mealy," but is liable to be heavy or "sodden." It is therefore not so suitable a food for invalids as is the white potato. While in most countries it is regarded as a vegetable, in some parts of Asia it is preserved as a sweetmeat. There is also a flour made from the yam, or sweet potato, in the East. Canned sweet potatoes are rapidly coming into favor, as this is a practical method for keeping them for use at all times of the year.

Steaming develops the flavor of the sweet potato better than boiling, and baking is a still better method of cooking. One peculiarity in the cooking of sweet potatoes is that they should be cooked slowly and for quite a long time. An hour in the oven is not too long to develop the best flavor.

Sweet potatoes are used with success for the manufacture of

[1] U. S. Dept. Agri., Farmers' Bull. Nos. 129, 295, 234, 419, and 520.

alcohol as both the sugar and starch are fermentable, but they are not considered as valuable for this purpose as are the Irish potatoes.

Nutritive Value

Since the sweet potato is deficient in both protein and fat, and peanuts are rich in both these nutrients, a well-balanced ration, as well as an agreeable food, is made by a judicious mixture of sweet potatoes and peanuts.

In addition to being an abundant crop over about one-half the area of the United States and especially on the Atlantic slope from New Jersey to Florida, the sweet potato is cultivated about the Mediterranean Sea, in China, Japan, the West Indies, Spain, the Philippines, and the Azores. In those countries where they grow readily they form a large proportion of the food of the inhabitants. In the Azores sweet potatoes are used for the manufacture of spirits. The quantity of sweet potatoes raised in the United States in 1910 is reported as 50,000,000 bushels.[1]

YAMS (Dioscorea batatas) (Dioscorea sativa)

The Yam, a larger tuber than the sweet potato and belonging to a different family, is grown in tropical and sub-tropical countries, where it is regarded as valuable food both for man and for cattle and hogs. In composition it does not differ much from the sweet potato although it is usually not so sweet. It often grows to great size (up to 30 pounds) in the East Indies, though under these conditions the flesh is somewhat tough and coarse.

TARO (Colocasia antiquorum, esculenta)

The corn-like rootstock of this plant which grows throughout the tropics is cultivated for food in China, Japan, and the Islands of the Pacific. The acrid root is made edible by heating or boiling.

[1] U. S. Census Reports.

This vegetable is something like the yam and the sweet potato in appearance, and is used as potatoes are commonly used in this country. These tubers contain about 18 per cent. of starch, 1.75 of sugar and 1.80 of total protein, and so are similar in nutritive value to the potato.

"*Poi*" is the name applied by the natives to the starch made by washing the roots and grinding them to a meal. It is often allowed to ferment during the process of manufacture. For making a porridge, it is stirred into hot water to the thickness of a paste and is not only a valuable food, but an excellent diet for invalids.

DASHEEN (Araceæ)

The dasheen[1] is a vegetable resembling the elephant ear or the Hawaiian taro, which may be readily grown in semitropical cli-

FIG. 25.—A field of Dasheen, Florida. (By permission U. S. Dept. Agric.)

mates. (Fig. 25.) It is a staple food for millions of people in tropical countries. The tubers are similar in composition to the potato, but contain more starch and protein. They have a flavor

[1] Circ. U. S. Dept. Agri., Bu. Foreign Plant Introduction: Circ. Bu. Plant Ind.

when cooked by boiling or baking which suggests boiled chestnuts. They have been successfully raised in the United States, in South Carolina and Florida.

Turnip (Brassica napus)

This root belongs to the order of *Cruciferæ*, so named because of its four petals arranged like a cross. It has been cultivated since the days of the Greeks, and grew wild in many countries. In Russia turnips are often classed as a luxury, and are sometimes eaten raw as a relish, in fact, this method of eating them is not entirely unknown in the United States and Germany. The Laplanders are also said to be exceedingly fond of this vegetable.

As the turnip grows late into the autumn, it is often sown after harvesting some earlier crop.

Composition

The spicy, pungent taste is due to the presence of an essential oil. As turnips contain over 90 per cent. of water they are not of much value as a nutrient food. They contain 6.27 per cent. of carbohydrates, which consists of sugar and a substance belonging to the pectose group, with very little starch.

Turnips contain less solid matter and more water than cow's milk. Their most important use is for feeding stock, although they communicate a valuable variety to human food. They have not received as much attention with reference to improvement by cultivation as has the sugar beet.[1]

MISCELLANEOUS VEGETABLES

Other vegetables used in some countries are "arrowhead" tubers, some kinds of which were used by the American Indians, and others by the inhabitants of China and India; lily bulbs, which are used as food by the Chinese and other Asiatic races;

[1] J. Soc. Ch. Ind., Vol. 16, pp. 213–219.

water-lilies, the roots of which were used by the Ancient Egyptians and the roots of the lotus which are used by the people of India, China and Japan.

OTHER "GREENS"

In addition to the vegetables already mentioned, a large number of other plants often called "pot herbs" are used as food. They are of comparatively little value as far as their nutritive quality is concerned, but they furnish abundant mineral salts such as the chlorides, sulfates and phosphates of sodium, potassium, iron, calcium and magnesium. These are considered to be of great importance in the animal metabolism.[1] Some of these vegetables are of positive value in the relief of chronic constipation and indigestion, and all are to be recommended as furnishing an agreeable variety to the food in spring and early summer, as they also serve to stimulate the appetite, distend the alimentary canal and make alkaline the blood that winter foods tend to make too acid. They are usually boiled and sometimes afterward chopped and served with hard-boiled eggs.

Among the important food plants of this family are: kohl-rabi or turnip cabbage, which has the stem, the edible portion of the plant, largely developed above the ground; kale, called also borecole, savoy cabbage, broccoli, sea-kale and "colewort" or "collards."'

Other vegetable substances of this class are spinach, one of the most valued, beet tops, dandelion tops, narrow-leaved dock, turnip tops, stinging nettle, swiss chard, plantain leaves, purslane ("pursley"), mustard, poke sprouts, dasheen leaves, pigweed, chickweed, and milkweed sprouts.

SALAD PLANTS

Salads are cold dishes, composed of either meat, fish or vegetables. They are served either with mixtures of oil and vinegar

[1] Chemistry of Food and Nutrition, Sherman, p. 260.

or lemon juice, or with oil, egg and vinegar.[1] The oil, or cream which is sometimes used, is a valuable nutrient, and should be added freely. In addition to fruits, left-over green vegetables served with French dressing are often utilized. The green vegetables contain valuable mineral salts, which can readily be introduced into the diet in this way. There are a large number of plants, the leaves and stalks of which have been used in salads for many centuries. They have, like the "greens" mentioned, little real food value, but have an incidental use as appetizers or diluents of the food proper.

In 1669 Evelyn[2] gave a list of seventy-three plants used in salads, but the use of many of these has long since been abandoned. In France, Germany and Italy salads are more universally used and a greater variety of plants utilized for this purpose than in the United States. The Orientals often add flowers to their salads, but probably in most cases this is more for the purpose of decoration than as a flavor.

It has been well remarked that too great care cannot be exercised in the thorough cleansing of such leaves and stalks as are selected for making salad, as this is the only precaution that can be exercised to prevent the introduction of worms and other small organisms into the body.

FIG. 26.—Artichokes.

ARTICHOKE (Cynara scolymus)

The green or true artichoke, which belongs to the thistle family, is cultivated for the sake of its immature flower heads, (Fig. 26) which are served either raw as a salad, or cooked in water or milk and served with a sauce. Is is in common use in central and southern Europe, where it it

[1] Mrs. Rorer's New Cookbook, p. 439.
[2] Food, A. H. Church, p. 119.

much more appreciated than in the United States. The artichoke is a diasetic, and since it contains inulin and no starch may be eaten by diabetics. Canned artichokes are exported from Italy and France. When the leaf stalks are blanched by tying them up the term "chard" is applied to the white and tender leaves. (See p. 167.)

CELERY (Apium graveolens)

This plant, which belongs along with many other herbs, to the Umbelliferæ, has within recent years come into considerable commercial importance. The wild celery[1] is a native of the marshes of southern England, and many parts of the continent. From England it was brought to the United States and one variety known as "smellage" or "smallage" was for many years cultivated in the old gardens for its foliage and as a salad plant. However, since it belongs to the same family as the poison hemlock, it was by many considered poisonous to eat. Gradually, since the middle of the last century, it has come into common use in the United States and is at present regarded as a valuable addition to our supply of foods and condiments.

The celery is a biennial, and produces its seed the second year, after which the plant dies. The first season after the seed is sown is used in building up an abundant storehouse for starch and other carbohydrates, so that it may be utilized the second year in the production of flowers and seed.

Growing Celery

In the United States there are two areas where celery may be grown with profit, viz., a northern area where it grows well in the summer, and a southern area where it can be grown during the winter months. It does best in a rich, mellow, sandy loam, and heavy manuring is necessary for a good crop. Usually the seed is sown in a hot-bed, and the young plants are set in rows as soon as

[1] U. S. Dept. Agri., Bull. No. 282.

there is no longer danger of frost. The plants require a large amount of water for their successful cultivation.

Blanching

As in the wild state the stems were tough and of a rank taste and odor, the quality has been improved by cultivation and "blanching" to develop the mild flavor and texture so much desired. This is frequently accomplished in the fields by placing boards about 12 inches wide on each side of the rows of growing plants. The operation of blanching requires two or three weeks. A more common method of blanching is by piling up the soil on each side of the row, while a method well adapted to use on a small scale is by the use of 4-inch farm drain tiles, which are placed over each plant. The enlarged succulent stalks of the basal leaves are the edible portion. On the Continent of Europe especially, the roots of one variety known as "*celeriac*" are boiled and eaten like turnips, or served cold with dressing as celery root salad. (Fig. 27.)

FIG. 27.—The celeriac plant and root.

Composition

Celery contains about 6 per cent. of proteins and carbohydrates, including 2 per cent. of sugar. Its taste is due to the presence of a very small quantity of essential oil. It is regarded by some as possessing certain valuable medical properties, but its value as a food accessory is largely due to the fact that it can be obtained when other green foods are not on the market, that it has an agreeable flavor, and that it dilutes the more concentrated forms of nourishment. "Celery salt" made from the ground seed is much prized for flavoring soups and salads. The outside stalks which are usually tough are often cooked and then the water in which they are cooked is strained and made into cream of celery soup.

In the United States celery is grown most extensively for the market in the drained "muck bed" areas of the Great Lake region and in Michigan, Ohio, New York, California, and Florida.

FIG. 28.—The chicory plant. (Photo by C. L. Lochman.)

CHICORY (Chiconium intybus)

The chicory is closely related to the endive and dandelion. (Fig. 28.) The leaves have a rather bitter taste but are used in salads. Under cultivation the large root which is developed is used after roasting for adulterating coffee or as an important constituent of a beverage of this class. (See Coffee, p. 474.) In the autumn the roots are dug, cut in small pieces and dried. When required for use they are roasted and ground like coffee. Much of the chicory used in the United States is imported.

ENDIVE (Chicorium endivia)

The endive sometimes called winter lettuce belongs, as does ordinary lettuce, to the same family as the dandelion. It was early cultivated in China and Japan, and is found wild in all countries surrounding the Mediterranean. The blanched leaves are the portion used, and although they would be acrid and tough if exposed to the air, the process of blanching makes them crisp and tender. This plant will also bear a comparatively low temperature without injury. Although it has been usually imported into America as yet, it is easily grown and is becoming more common.

LETTUCE (Lactuca sativa)

Lettuce is perhaps the most important of these succulent vegetables. It probably came originally from India or central Asia and was held in great esteem by the ancients. In 1520 it was introduced into England from Flanders. There are many varieties, some of which are spreading, and have large succulent leaves, while in others the leaves are drawn together similar to the cabbage and are crisp and nearly white. The varieties may be classified as (1) cabbage or head lettuce, (2) "Cos" or leaf lettuce, named from the Island of Cos, near the coast of Greece, and (3) cutting lettuce from which the leaves are cut as they mature.

There is not much food value in the lettuce, although its mineral salts may be of use in the processes of metabolism. Some ascribe medicinal virtues to the lettuce on account of its containing a small quantity of a sleep-inducing substance called "lactucarin," which is found more abundantly in the stem. Others have recommended it[1] for supplying iron in the organic form, as this element some believe is in this plant, chemically combined in the chlorophyl. As a wholesome, cooling, agreeable salad plant, lettuce has always been a favorite throughout temperate and semi-tropical countries.

RADISH (Raphanus sativus)

The radish, although its root is the part generally used, may be classified here, as it is seldom eaten in any other way except raw and as a salad. This plant was originally grown in India, and later introduced into Great Britain and the United States. Many of the edible varieties are small and quickly grown; but large radishes are also used. One of the winter radishes, a Japanese variety, sometimes attains a length of 2 feet, and is a foot in diameter. It is commonly cut in chunks and pickled in brine. The radish has a somewhat pungent taste, and is valuable as an antiscorbutic.

MISCELLANEOUS SALAD PLANTS

Other salad plants are the cardoon, which is something like the artichoke and the leaf stalks of which are blanched like celery, which is eaten as a vegetable in soup or as a salad. It grows in the countries which surround the Mediterranean. The tender leaf stalks of several varieties of thistle are used as food in some countries, and the young leaves and stalks of the mallow.

Other plants of this group, some of which have vegetable acids or essential oils which give them a characteristic flavor, are borage, burnet, cress, water-cress, cowslip, corn salad or Lamb's lettuce, caper, chevril, mint, nasturtium, parsley, pepper grass, peppers (green), sorrel and taragon.

AROMATIC AND MEDICINAL HERBS

The following aromatic and medicinal plants, although not properly belonging to the class of foods, are often used in foods for flavor-

[1] Human Foods, Snyder, p. 42.

ing or garnishing, and may be grown in the vegetable garden: Anise (seeds), balm (leaves), caraway (seeds), catnip (leaves), coriander (seeds), dill (seeds), horehound (leaves), hyssop (leaves), lavender (flowers), rosemary (leaves,) rue (leaves), sage (leaves), saffron (flowers), savory (leaves), sweet basil (leaves), sweet fennel (seeds), sweet majorum (leaves), sweet thyme (leaves), wormwood (leaves).

For description of the most important of these see Spices and Condiments, p. 440.

CHAPTER VII

LEGUMES (Leguminosæ)

The **legumes,**[1] or **pulses,** as they are called in England, stand next in importance to cereals among vegetable foods. They include beans in great variety, chick peas, peas, lentils, peanuts and a few other plants. They have been in use for so many hundreds of years and in so many countries that their origin is lost in antiquity. In China, India, northern Africa and other countries bordering on the Mediterranean Sea, they have formed an important part of the food of the common people for centuries.

The plants of this family all have a characteristic papilionaceous or butterfly-shaped flower, and the seed grows in pods, containing sometimes few and sometimes a large number of individuals. Many of these plants are broad-spreading trees, which yield fruit entirely inedible for man, but most of those bearing edible fruit are low and herbaceous.

Perhaps the most interesting characteristic of the family is, that many of the plants not only furnish a valuable food, but at the same time actually increase the fertility of the soil in which they are grown. This is due to the fixation of atmospheric nitrogen by the bacteria working unceasingly in the laboratories of the root nodules. It is only within the last fifty years that these facts in regard to the soil-fixation of nitrogen[2] have been understood, although the practice of plowing under cow peas, clover and similar crops has been common for many years.

Beans and peas grow rapidly, and therefore can be grown in the northern countries, as three or four months only are needed to bring them to full maturity. They are cultivated as garden

[1] U. S. Dept. Agri., Farmers' Bull. No. 121.
[2] U. S. Dept. Agri., Farmers' Bull. No. 315.

crops, and have the advantage of not requiring any special kind of soil and indeed they will not refuse to grow and produce a fair crop on comparatively poor soil. This is largely due to the fact that they can avail themselves of this double supply of nitrogen—that which is contained in the soil as nitrites, nitrates and ammonia, and that which is collected from the air by the root nodules.

Since **protein food** is usually expensive it would seem that in beans and other legumes we have found a cheap and abundant source of this kind of nutrient, and to a certain extent this is true, and beans have been extensively utilized for this purpose. It happens, however, that the protein exists in the legumes in the form of legumin with but little albumin. As has been pointed out by Voit, vegetable foods in general are less completely digested than animal foods, and this legumin is acted on mainly by the ferments which work in alkaline solutions, especially in the lower part of the alimentary system. On this account, then, beans are not readily digested in the stomach, although they are absorbed by the intestines.

Nutritive Value

Numerous experiments[1] have been made to find out to what extent the protein of beans, peas, etc., is actually utilized as a nutrient in the system. Some of these experiments seemed to indicate that there was a much greater waste of protein than when meat or wheat was used as food, but later results show that, with certain limitations and precautions, the protein of the legumes is fairly well digested. The legumes do, however, require more work by the digestive tract than many other foods. If beans or peas are ground before being cooked, the absorption of protein is more complete. It is also well established that if they are combined with other foods, and do not form too large a proportion of the diet, the nutriment is much more completely utilized than when they are used alone. In comparison with other vegetable proteins, the legume proteins are less well utilized.[2]

[1] Human Foods and Their Nutritive Value, Snyder, p. 72.
[2] Jour. Biolog. Chem., Vol. 10, p. 457.

The flatulence that is often occasioned by the use of a diet consisting largely of beans is probably caused by the decomposition by bacteria of the germ of the bean in the intestine, giving rise to a considerable quantity of the hydrocarbon, methan (CH_4). The abundant sulfur found in the protein of beans may also have something of the same effect.

Legumes as Food

It is true that beans form an admirable and cheap addition to the food of persons engaged in manual labor, and persons exposed to severe weather, for in lumber camps and mining regions they are used in great quantities and with little discomfort. Under such conditions, a pound of baked beans per person a day produces no ill effects. People of sedentary habits, however, are not able to digest large quantities of leguminous foods, and whenever these foods are used an abundance of other nutrients should be eaten at the same time.

Says Hutchinson, in speaking of the pea and bean,[1] "As a cheap and efficient method of supplementing the deficiency of nitrogen in a purely vegetable diet, however, their use is strongly to be recommended, and it is a pity that they are not more largely taken advantage of by those to whom economy is of importance, for unquestionably the pulses are among the cheapest of foods, and a given sum will yield more protein, if invested in these, than in any other way." Flour made from beans or peas is used to a limited extent in some countries. As the legumes when ground into flour furnish a more digestible food than when used whole, it is rather remarkable that this product is not more generally placed on the market.

BEANS

The bean on account of the numerous ways in which it can be prepared for food, and because it is so readily grown, is one of the

[1] Food and Dietetics, p. 224.

most important of the legumes. It is believed that beans were cultivated by the Indians of both North and South America, and we read of the Algonquins having one or two varieties of pole beans. Champlain speaks of planting the "Brazilian bean" in the region of the Kennebec, and bean flour is mentioned as having been in use among the Aztecs.

Beans may be grown for use as "snap" or "string" beans, as fresh or green beans, or they may be allowed to dry and be kept for winter use. For the latter purpose very large quantities are grown on a commercial scale in the United States and abroad.

Composition

The amount of starch and protein in some of the common edible beans is as follows:

	Carbohydrates	Proteins
String beans	7.4	2.3
Shelled kidney beans	29.1	9.4
Shelled lima beans	22.0	7.1
Canned baked beans	19.6	6.9
Dried navy beans	59.6	22.5
Dried lima beans	65.9	18.1
For comparison, wheat flour contains	74.5	11.7

The protein of beans is called legumin, and consists chiefly of phaseolin, and a small quantity of phaselin.

Cooking

The process used in cooking beans is of greater importance than is the case with most other vegetables. Young, absolutely fresh string beans can be thoroughly softened in from one to one and a half hours' boiling. The Germans pack string beans in salt, and thus cure them by a process in which lactic fermentation milar to that used for sauerkraut, occurs. They are then soaked out and freshened with water before using.

Shell beans, which must also be fresh, should not be overcooked, or they will lose their fine flavor and become yellowish brown. The addition of butter, after the vegetable is cooked, improves the flavor and increases the food value of the product.

Lima beans and kidney beans are often put upon the market canned, but the greatest demand is for "baked beans," which are frequently flavored with "tomato sauce," molasses, pork, etc. It is a question whether some of the so-called "baked beans" on the market should really bear this label, as the product differs so decidedly in method of preparation and quality from the domestic article.

In the *cooking* of dried beans it is advisable to use a little baking soda in the water, as some of this enters into combination with the legumin and renders this substance more digestible. It is the common household practice to soak the beans for at least eight hours before boiling. The food is made more digestible if the skin which contains much indigestible cellulose is removed before cooking. This can be readily done by boiling with a small amount of baking soda, and then washing in cold water. The main requirements for cooking dried beans are, to soften the cellulose so that the beans can be easily masticated and thus render them more accessible to the digestive enzymes, to so cook the protein as that it shall be digestible and palatable, and finally to swell the starch grains.

Experiments show that soft water is much more suitable for use in cooking beans and other legumes than hard water; rain or cistern water is the best, although of course there is no objection to the use of distilled water. The reason for preferring soft water is that the lime of hard water forms insoluble compounds with the proteins of the legumes, and then no amount of cooking will soften them.

It has been universally conceded that long cooking at a moderate temperature develops the flavor of beans and most effectually softens the tissue. This is illustrated by the delicious flavor of the old-fashioned "pork and beans" of New England, which was baked for at least twelve hours in the slow cooking brick oven. The addition of fat, as salt pork, not only improves the flavor, but supplies needed ingredients to make a better balanced ration.

Lima beans (p. lunatus), both pole and dwarf, are favored in the dietary, on account of their size and flavor. They are especially used in making the well-known North American Indian dish, called "succotash." (See Corn, p. 43.) A variety of the kidney bean very extensively grown, and used especially in France, is known as the haricot or in the United States as the "navy bean." The large yellow bean grown in Italy forms such an important part of the food that it is cooked and exposed on the streets for sale. The broad bean (Vicia faba), which is one of the oldest of these leguminous plants known, grows well in the northern United States and in Canada, and is an important crop in Europe. It is not so well suited to countries liable to prolonged rainless periods.

Soy Beans

Soy beans (Soja bean) (Glycine hispida) have been recently introduced into the United States from Japan.[1] The foliage is used as food for stock, and the beans are much used as food for man in southeastern Asia but, perhaps because a taste for them has not yet been cultivated, they are not extensively used as human food either in Europe or America. This bean has a remarkably high per cent. of protein (35 per cent.), and contains 20 per cent. of fat[2] and some cane sugar. It is asserted by a recent author[3] that soy bean flour contains no starch or reducing sugar. If this proves to be the case this flour will be of great importance in the feeding of infants and diabetic patients.

[1] U. S. Dept. Agri., Farmers' Bull. No. 372.
[2] Tennessee Agri. Ex. Sta. Bull. No. 82.
[3] Rühral (Abst.) C. A., Vol. 6, p. 1789.

Preparations from the Soy Bean

One variety of soy bean analyzed[1] contains:

Water	9.80
Protein	37.13
Carbohydrates	24.40
Fat	18.36
Lecithin	1.62
Crude fiber	4.47
Ash	4.30

In China, Manchuria, Korea and Japan the soy bean supplements very well the rice diet of the natives, as it furnishes both protein and fat in which the rice is so deficient. This is especially the case in those districts where fish are not available at a moderate cost. In the recent war between Russia and Japan soy beans were the chief food-stuff upon which dependence was placed.[2] A sauce called "soy sauce," having a pungent and agreeable taste, is also made by fermenting for several months with a special ferment a mixture of cooked soy beans, roasted wheat flour and salt. Other leguminous products often called "bean cheeses" are used in these countries. "Natto,"[3] is made from the boiled beans packed in rice straw and allowed to ferment. The mass becomes white and mucilaginous by the development of bacteria, and the straw flavors the product.[4] Other foods are "miso," a fermented product made from beans, barley and salt, and "tofu," which is made by crushing and boiling the beans and filtering through cloth. Two per cent. of concentrated sea brine is added to this, which, probably on account of the calcium and magnesium present, precipitates the plant casein, which is then pressed into white tablets. Soy milk is made by boiling the beans, and beating to a pulp, when some of the vegetable casein passes into solution, and a milky looking liquid is obtained. Soy bean oil will, no doubt, eventually be used for many purposes, perhaps as food in the United States,

[1] Chem. Abs., Vol. 2, p. 864.
[2] Lewkowitsch, Chem. Ind., 33, 705–8.
[3] Eighth Int. Cong. Appl. Chem., 18–251.
[4] Jour. Ind. and Eng. Chem., Vol. 4, p. 897.

just as cotton-seed oil has come into extensive use within the past thirty years. It is used mixed with cotton-seed oil as a salad oil. (See p. 316.)

The locust bean (Ceratonia siliqua), under the name of St. John's bread or locust or carob bean is sold in the markets of the larger cities of the United States. It comes originally from Syria and on the shores of the Mediterranean is grown as food for cattle. This bean was much in favor among the Arabs, who extended its growth as far as Morocco and Spain. It appears in all the central European fruit markets. The ripe seeds are surrounded by a sweet mucilaginous mass, which is, however, by some appreciated more as a confectionery than as a food. The dried pod yields 50 per cent. of sugar. Another bean of local importance is the Frijole, which is largely grown and used as a staple food in Mexico and the Southwest. In fact next to corn (maize) these beans form the principal part of the diet of a large number of people. The beans are small, flat and usually of a reddish-brown color and are extensively used as "snap" beans. Canned beans either green wax or "snap" are becoming an important food product. They are "processed" in tin cans in the same way as peas.

The *tamarind* (Tamarindus indica) is the pod of a leguminous tree growing in tropical Africa, the East and West Indies. The name in Arabic signifies "Indian date." The seeds are used as an astringent, the leaves to furnish a dye stuff, and the wood for timber. The beans are surrounded, inside the pod, with a dark-colored pasty material, which is the edible portion of the fruit. This has a pleasant sweetish-sour taste, and upon analysis is shown to contain 82 per cent. of total solids, 15 per cent. of acid, mostly tartaric, and over 40 per cent. of reducing sugar. In fact, it contains more sugar than the sweetest fruit, and more acid than the sourest fruit. The large amount of sugar is not, however, enough to entirely mask the effect of the acid, and the taste is distinctly sour. On account of this peculiar composition tamarinds are used to make cooling, sub-acid beverages, especially for invalids. The fruit is official in the Pharmacopoeia as a laxative and refrigerant.

Tamarinds are preserved either by the addition of salt and drying in the sun, or by putting in jars and covering with sugar sirup. Tamarind paste, which is a mixture of the pulp and about 75 per cent. of sugar, is a valuable commercial product. By mixing an ounce of the tamarind pulp with about 1 1/2 pints of warm milk a nourishing beverage, called "tamarind whey," is obtained. The young pods are sometimes cooked with rice and fish.[1] The paste inside the pods is in some countries sold in balls weighing about 3 ounces, and these are used for making a laxative beverage. The pulp is also used to adultĕrate guava jelly, but this substitution may be readily detected by the presence of tartaric acid in the product, as this acid is absent in true guava jelly. From tamarind seeds, an oil may be made which is suitable to use in paint, and has greater drying qualities than linseed oil. The roasted seeds are said to be superior to peanuts in flavor, and a valuable food product.

The *cow pea* (Vigna catjang), is properly a bean, and was originally brought from China or India, where it is in common use. This bean may be cooked and eaten green, or the dried bean may be cooked. Although indigenous to equatorial Africa, it grows readily in many sub-tropical countries, as in the Southern States. As it requires quite a long season in which to mature its seed, the cow pea cannot be successfully grown in the Northern States. Many varieties have a pleasing and delicate flavor, and are considered a staple crop in the warm countries. They are used in the pod, shelled green and shelled dry.[2]

Enough has already been said in regard to the raising of beans in different parts of the world to show their general use. In the United States the three most important bean-producing states are Michigan, New York and California, although the crop is readily grown from Florida to Minnesota. The bean crop of 1909

[1] Phil. Jour. Science, Vol. 8, Sec. A, p. 71.
[2] U. S. Dept. Agri., Farmers' Bull. No. 559.

in the United States was 11,145,000 bushels. There were imported into the United States in 1911, 1,037,371 bushels of beans. The greatest bean-producing country is Italy, which raised 20,632,000 bushels in 1910. Spain is next in importance producing 13,454,000 bushels the same year.[1]

PEAS (Pisum sativum)

Although it is known that the Greeks and Romans cultivated peas, yet they do not seem to have been in common use as long, nor to have been as universally grown as beans. They were no doubt introduced into Europe by the Aryans, and were first brought to England, where they were regarded as a great dainty, from Holland in the seventeenth century. Peas are more often used when green than is the case with beans, and less so when dry.

Composition

Much that has been said in regard to the growth, composition and digestibility of beans applies equally well to peas. Their composition is as follows:[2]

	Water	Ash	Protein	Fiber	Starch, sugar, etc.	Fat
Green pea	79.93	0.78	3.87	1.63	13.30	0.49
Dry pea	12.62	3.11	27.04	3.90	51.75	1.58

Comparing this analysis with that of the bean, it is evident that peas, especially when dried, are even more nitrogenous than beans, and nearly all this nitrogenous material is said to exist in the form of proteins. The protein of peas consists chiefly of legumin, a globulin not coagulated by heat and vicilin.

[1] Year-book, U. S. Dept. Agri., 1911.
[2] Foods and Their Adulterations, Wiley (2d Ed.), p. 288.

The unripe or green peas are more digestible than are dried peas and they contain considerable sugar, which greatly improves their flavor. The field pea (pisum arvense) is often grown to furnish the "split peas" of commerce. In preparing these for market the outer skin is removed, thus increasing the digestibility of the product. Pea flour has a considerable sale, especially abroad, and is used in making soups. The "Erbswurst," so much in use in Germany, especially in the army, is composed of pea flour, fat pork and salt and is so nutritious that a comparatively small amount will sustain the men for a long march. This diet, however, is liable to become monotonous, and to produce irritation in the alimentary canal.

Canned Peas

Canned green peas are a very important addition to the dietary, especially in the United States. If the process is well conducted, and the peas are not too mature, an extremely edible product is available for use throughout the year. Canned peas have been subject to several methods of adulteration. They may be sweetened by saccharin, but this is not permissible in the United States in samples going into interstate commerce.[1] It has also been the custom to produce an artificial green color, by the use of salts of copper, but this practice has been virtually discontinued here although still practised abroad.[2] Old or dried peas are sometimes soaked for a long time and then canned and put on the market as fresh or green peas. In some states the law provides that such a product shall be plainly labeled as "soaked goods." They are lacking in flavor and are of very poor quality. They may usually be detected by the fact that the root of the embryo has started to grow due to the long soaking.

Pea Growing

Peas are not grown as far south as are beans, yet throughout the north temperate zone there is a wide area where they are

[1] F. I. D. No. 135, U. S. Dept. Agri.
[2] F. I. D. No. 92.

raised, both in the garden and on a commercial scale for the market. In Mediterranean countries, Spanish America and in British India, the chick pea or gram (Cicer arietinum) is extensively used. This is the "garbanza" of Spanish cookery. It is a large pea and grows singly in round pods. Although these peas may be boiled for use, they are more commonly roasted, and still form an important article of food for travellers in Oriental lands. It was perhaps the "parched pulse" of the ancient Hebrews. It is known also as an ingredient of the distinctly Spanish dish "olla podrida."

LENTILS (Lens esculenta)

This is a very ancient food plant, and one of the earliest brought into cultivation. The Bible tells of its use in Egypt, Asia and Mediterranean countries. The "red pottage" for which Jacob sold his birthright to Esau was composed largely of lentils.[1] The European market is even now principally supplied with lentils from Egypt, although they might be readily cultivated farther north. In the preparation for market, the outer skin is usually removed.

With the increasing immigration from southern Europe, where lentils are more used than formerly, they have also become more popular as a food in the United States. In composition the lentil is one of the most nutritious of all the legumes, and contains the highest per cent. of protein. According to Church[2] it contains 25 per cent. of albuminoids, etc., 56.1 per cent. of starch and 2 per cent. of fat. Lentils also contain a little sulfur and some varieties are particularly rich in iron. They are considered more digestible than either peas or beans. It is probably on account of the strong flavor, and because other legumes that are considered more agreeable are so abundant, that lentils have not come into more general use among the people of the northern countries.

The favorite method of serving lentils is in the form of purée and in soups and stews. There are at least three varieties,

[1] Genesis 25:34.
[2] Food, p. 97.

one similar to the common pea, one a larger yellowish variety, and a third a small brownish or reddish seed, of more delicate flavor.

A proprietary food known as "*revalenta arabica,*" consisting mainly of lentil flour, is found in the market. This may also contain ground peas, beans, corn, wheat or barley. According to Hutchinson, analysis showed that this food contained less protein than the lentil flour. During Lent the Catholics use lentils in the place of meat, and lentil flour is used by the Hindoos, when engaged in laborious work, to supplement their diet of rice.

Lentils can be readily grown in the southwestern United States and Mexico, and their cultivation has already been started in these sections of scanty rainfall, sandy soil, and moderate fertility.

PEANUT (Arachis hypogæa)

The peanut, although usually known as a nut, is in reality a pea, bearing its fruit beneath the surface of the ground rather than above. (Fig. 29.) This is the storehouse of starch and fat for the growing plant, and the plant is propagated by planting these nuts. The peanut is known under various names as "groundnut," "pindar" and "goober."[1]

As there are several allied species of the peanut plant in Brazil, and as a wild "goober" grows in the southern Gulf States, it seems probable that the peanut is of tropical American origin. Although introduced into the United States quite early, the peanut did not become an important commercial crop until about 1870. It has been grown in Africa for many years and some varieties may have originated in that country.

Peanut Growing

As it is somewhat unique, a word in regard to the way in which the peanut is grown may be of interest. The small yellow flowers are borne in a little pocket where the leaves are attached to the stem, and as soon as the flower fades, the elongating stem thrusts

[1] U. S. Dept. Agri., Farmers' Bull. Nos. 121, 332, 356.

the ovary beneath the surface of the soil, where the pod is subsequently developed. If the ovary does not get beneath the surface no fruit is formed.

Peanuts grow best on a well-drained, sandy loam, and require a long season without frost (from ninety to one hundred and twenty days), small rainfall during the growing season, a high

FIG. 29.—The peanut plant, showing the pod growing beneath the surface of the ground. (Wiley.)

temperature and abundant sunshine. It should not be forgotten that, like other legumes, the peanut is a soil-renovating and a soil-improving plant, through the nitrogen of the atmosphere collected in the root-nodules. Peanuts are picked from the roots and vines, either by hand or machinery, and are mechanically sorted and thoroughly cleaned at the factory. There are four distinct varieties raised in the Southern States, viz., Virginia bunch, North Carolina, Spanish, and Tennessee red.

Composition

Although the composition of different varieties differs considerably, the average may be stated as consisting of protein 26 per cent., of oil 38 per cent., and of sugar, starch, etc., 24 per cent. They are therefore extremely rich in oil and protein. In the roasted peanut, as the water is reduced to less than 2 per cent., the quantity of oil may be as high as 51 per cent. and of proteins 28 per cent.

Use as Food

Peanuts may be regarded as wholesome food, if not used in too large quantities, but they should be mixed with other food. Peanut flour is such a highly nutritious food material that experiments have been made with a view of using it as a constituent of a concentrated food product for soldier's rations.[2]

The use of peanuts has increased enormously in the United States in the last ten years, both as stock food, and for human consumption. For the latter purpose peanuts are roasted, thereby improving the flavor which is probably due to the browned starches, proteins, oils, etc. Prepared in this way peanuts are coming into very extensive use either as a confection, "salted peanuts," or in candies, "peanut brittle," or for other confectionery purposes. The unroasted peanut has the taste of uncooked beans or peas. There is an advantage in using the peanut with sugar or with popcorn and puffed rice, as this combination makes a better balanced ration.

Peanut Products

The use of peanut butter and a preparation called peanolia is also on the increase. In the manufacture of these products, the peanuts are carefully roasted, then thoroughly cleaned to

[1] Proc. Ia. Acad. Science, 10, pp. 108–111.
[2] Practical Dietetics, Thompson, p. 165.

remove the outer coating and the germ, and finally ground in a special mill. This product, sometimes fresh, and sometimes salted, is put up in sealed packages or in wooden tubs and placed on the market by the ton. The factory process can be practically imitated at home by the use of a small meat grinder. "Vegetable meats" are prepared from peanuts by expressing some of the oil and adding to the residue various vegetable substances. Peanut meal is largely used in confectionery, especially for making imitation almond macaroons, and small cakes. The oil of peanuts is easily expressed, of excellent flavor, high nutritive value, and possesses much better keeping qualities than some of the other oils used for salad purposes. (See Fats and Oils, p. 313.)

In the United States for commercial purposes, peanuts are chiefly cultivated in Virginia, Tennessee, the Carolinas, Oklahoma and Georgia, but they may be grown throughout the Southern States, and southern Missouri and Kansas, as well as in California. Most of the manufactured products, however, come from the six states first mentioned. A yield of 50 bushels per acre is considered a fair crop. The value of the peanut crop in 1908 in the United States was estimated at $12,000,000.

CHAPTER VIII

THE CULTIVATION, PRESERVATION AND USE OF FRUITS AND BERRIES

The culmination of the annual or biennial life of plants is at the time when their seed is produced and ripened for the further propagation of the species. Closely associated with the seed is the pulp or fleshy part of the fruit or berry, which usually is present as a vegetable mass surrounding the seed. This is often edible and brightly colored so that it attracts the birds, insects and quadrupeds, who thus assist in scattering the seeds. Primitive man was no doubt attracted in the same way by the color, odor and appearance of the wild fruits, and if the taste proved to be agreeable, he continued their use. Incidentally the fruits appeased his hunger, and soon he used them to sustain life. Some fruits, however, must have produced disagreeable symptoms when first eaten, and some would produce death. In this case the word would be communicated to others that the fruit was poisonous and hence should always be avoided. It was not necessary for primitive man to possess a knowledge of the constituents of fruits, as he was only concerned with the agreeable taste, and their power to sustain life. It naturally follows that the abundance of wild fruits in certain regions at particular times of the year attracted the nomadic people to that locality. When they had harvested these fruits they would move to some other locality to obtain other food products.

As man arose in the scale of civilization he began to study other problems in relation to fruits. He tried to learn whether they might be cultivated to advantage, whether they were liable to be injured by disease or insect pests and what were their keeping qualities. The inquiry would then be pushed still farther so as to learn what their nutritive qualities were, and their physiological action.

In temperate climates we are accustomed to regard fruit as an agreeable addition to the diet, rather than a staple food. In this way oranges, apples, peaches, cherries, grapes and melons are used. In tropical countries, however, the fruits are the food, and frequently almost the only food of the natives. Without the banana, the bread fruit, the fig, the date and the cocoanut these people could not live so easily, and if they were deprived of their accustomed fruit diet they would find that much greater labor on their part would be necessary to obtain food enough to sustain life.

Botanically speaking, a fruit is the ripe or ripening ovary with its contents and any closely adhering parts. The fruit nourishes the young seed and protects it during its development. The fleshy portion surrounding the seeds is known as the pericarp. The green fruit does not differ very much from the leaf in composition, but under the influence of sunlight in the process of ripening, there is a remarkable change in size, color, texture, composition and flavor, as the ripening fruit begins to absorb oxygen and to give out carbon dioxide.

Cultivated fruits and berries have been developed from the wild varieties and it is possible in different countries to trace most of them from some special wild variety. Some berries, as blueberries, have never been much improved from the original wild varieties. Both the wild and cultivated cranberry, strawberry, blackberry and raspberry are used as food. There are some fruits, as elderberries, mulberries and service berries, which are eaten by birds but which have thus far found slight favor as food for man in this country, although sometimes used in making wine and mixed with other fruits in making sauce.

In North America the Indians used the wild berries and fruits, but as they were a nomadic people in their habits, made no attempt to improve them by cultivation. The white immigrants, however, saw the possibilities for improvement in these products, and early in the nineteenth century began to select and improve them. Sometimes, it is true, the flavor of fruits and berries has been sacrificed for size, color, texture and abundant fruitage, but this is not usually the case.

That the kinds of fruits and vegetables in use by civilized man has not increased very much is shown by consulting the earlier literature and by inspection of some of the noted paintings of artists of the sixteenth century, like those of Snyder.

There has been a tendency to eliminate the seeds from edible fruits, as these become unnecessary by the methods of propagation now employed, and their growth may then be considered a "waste of energy" on the part of the plant. The fact should, however, not be lost sight of that the presence of the seed in the fruit may influence the flavor.

By some early natural selection, no doubt, the seeds were practically eliminated from such a fruit as the banana, and the cultivation and propagation of seedless "sports" has been practised in recent times, and has resulted in the production of the seedless orange and lemon, and to some extent the seedless persimmon and other fruits.[1]

Classification

Fruits are for convenience divided into the following classes:[2]

A. *Orchard Fruits.*

1. Pome Fruits.
   Apple (crab apple), loquat, medlar, pear, quince.
2. Drupe Fruits.
   Apricot, cherry, date, nectarine, peach, plum, persimmon.
3. Citrus Fruits.
   Citron, grape fruit (shaddock or pomelo), kumquat, lemon, lime, mandarin, orange, tangarine.

B. *Vine Fruits.*

1. Grape.

[1] U. S. Dept. Agri., Farmers' Bull. No. 293.
[2] Cyclopedia of Am. Horticulture, L. H. Bailey (in part).

C. *Small Fruits.*

1. Blackberry, blackcap, blueberry (cloudberry), barberry, cranberry, currant (red and white), currant (black), dewberry, elderberry, gooseberry, huckleberry (whortleberry, bilberry), loganberry, mulberry, raspberry (red and white), serviceberry, squawberry, strawberry.

To this list may be conveniently added:

D. *Miscellaneous Fruits.*

1. Agave, avocado (alligator pear), banana (plantain), bread fruit, fig, guava, mango, olive, papaw, pomegranate, prickly pear, pineapple, cashew fruit.

E. *Garden Fruits.*

1. Citron, cucumber, egg-plant (aubergine), vegetable marrow, melon (cantaloup, muskmelon), watermelon, pumpkin, squash, tomato.

Composition

Practically speaking there is very little in fruits besides a solution of sugar, starches, pectin, and organic acids, delicately flavored with essential oils and aromatic ethers, and the cellulose of plant structure. Cellulose gives stability to the structure, and may furnish a small amount of nutriment. Usually about 80 per cent. of the fruit is water, and the remaining 20 per cent. consists of the above substances with insoluble matter like cellulose, gums, etc. The nutritive value of fruits lies in their soluble and insoluble carbohydrates, proteins, fats and mineral salts, just as it does in these constituents in other foods; but from the agreeable taste of fruits and the mechanical condition in which the nutrients are found there is no doubt added value.

The carbohydrates,[1] such as cane sugar, grape sugar, fruit sugar, starch and pectose, are the most abundant nutritive constituents. The exact kind of sugar present is influenced by the stage of ripeness of the fruit, as many chemical changes take place

[1] U. S. Dept. Agri., Farmers' Bulletin, 293.

during the ripening and maturing process. The amount of the different sugars and of the acid in common fruits is as follows:[1]

	Cane sugar	Reducing sugar	Acid
Apricots	6.04	2.74	1.864
Pineapples	11.33	1.98	0.547
English cherries	0.00	10.00	0.661
Lemons	0.41	1.06	4.706
Figs	0.00	11.55	0.057
Strawberries	6.33	4.98	0.550
Raspberries	2.01	5.22	1.380
Gooseberries	0.00	6.40	1.574
Oranges	4.22	4.36	0.448
Peaches (green)	0.92	1.07	3.900
Pears (madeleine)	0.36	8.42	0.115
Apples	2.19	5.45	0.633
Prunes	5.24	2.43	1.288
Grapes (hothouse)	0.00	17.26	0.345
Grapes (green)	0.00	1.60	2.485
Bananas	20.00	20.00	0.300
Apples	5.28	8.72	1.148

The changes that take place in the process of ripening are admirably shown in a series of Analyses of Baldwin Apples made by the Pennsylvania Department of Agriculture, and published in their bulletin No. 58. Samples of "very green," "green," "ripe" and "overripe" apples were taken, and analyzed with the following results in the order mentioned: Invert sugar 6.40, 6.46, 7.70, 8.81; sucrose 1.63, 4.05, 6.81, 5.26; total sugar by addition 8.03, 10.51, 14.51, 14.07; starch 4.14; 3.67, 0.17, blank. The free malic acid in the "very green" apples was 1.14 per cent. and in the overripe apples only 0.48 per cent.

Vegetable Acids

In the entire range of foods, it is only in fruits that the vegetable acids are in sufficient abundance to be of importance. They also add much to the flavor of fruits.

[1] Ann. Chem. Phys., 59, p. 233. See also Food Inspec. and Analysis, Leach, 3d. Ed., p. 566.

Only a small number of *organic acids* are found in fruits.[1] These are malic acid ($H_3C_4H_4O_5$), which occurs especially in apples, pears, currants, berries, pineapples, grapes and cherries; citric acid ($H_3C_6H_5O_7$), which is found most abundantly in the juice of limes, lemons, oranges, currants, unripe tomatoes and gooseberries, and tartaric acid ($H_2C_4H_4O_6$) which is the characteristic acid of grapes. In the latter fruit the acid occurs as acid potassium tartrate ($KHC_4H_4O_6$), the well-known basis of the "cream of tartar" of commerce. (See p. 264.) Racemic acid, a variety of tartaric acid, is found in smaller quantities in some fruits, especially in grapes. Acetic acid is not a normal constituent of fruits, but results from the fermentation of sugars and starches in fruits. (See Vinegar, p. 235.)

The above fruit acids are found in various proportions in fruit juices, where they occur usually as acid salts of potassium, sodium or calcium, imparting an agreeable flavor to the juice, and adding a wholesome and stimulating variety to food. It is a question whether these acids, even when prepared from fruit juices, can be added to foods and produce as wholesome a product as those found in the natural combinations in the fruits.[2]

Although the amount of vegetable acid in most fruits is not large, as is shown in the previous table, often this amount cannot be judged correctly by the sense of taste, as it is well known that sugar masks the sour taste. The tamarind has a high percentage of sugar but still has a decidedly sour taste, because it is very rich in both acid and sugar.

Pectin Bodies

Another important constituent of fruit is the pectin bodies which are somewhat like sugar and starch, and yet have their own characteristic properties. These substances, when vegetable acids are also present, give fruit juices the property of forming a thick mass or jelly, especially on cooling after boiling and often by con-

[1] Univ. of Ills. Bull. Vol. 9, No. 36, 1912.
[2] Foods and Their Adulteration, Wiley, p. 328.

tinued exposure to sunlight. Pectin is present in nearly all fruits, although some are much better adapted to jelly making than others.

Pectin is frequently not found in the juice of *raw* fruits.[1] Experiments have shown that there is little or no pectin in the juice of *raw* apples, *raw* grapes, and none at all in the juice of *raw* quinces. In the juice extracted from these fruits by cooking, however, there is an abundance of pectin. The juice of some fruits, as currants and blackberries, even if obtained from the *raw* fruit, contains considerable pectin, but that from the cooked fruits is much richer in this material, and a clearer jelly is usually obtained.

Fruits yield this gelatinous material best by being cooked with water, but in the case of berries and very juicy fruits but little water need be added. Some juices will partially solidify without heating but it is advisable to boil the juice for a few minutes.

These bodies are found both in the juice and the "marc," or insoluble part of the fruit. By boiling with water the latter variety becomes soluble. The pectins are precipitated or thrown out of solution by such substances as alcohols, sugars, salts, etc., therefore hard water should not be used in the treatment of the raw fruit.

Pectin bodies yield reducing sugars, furfurol and mucic acid in varying quantities, by chemical treatment. We are still somewhat at a loss to determine the exact function of pectin bodies in fruits and vegetables, although it has been suggested that they are reserve material or a by-product, or perhaps a substance needed in building up the structure of the organic constituents. These pectin bodies are usually regarded as resulting from the combination of several simpler carbohydrates.[2] As they are closely related to starch and also to gum arabic, this property of gelatinizing is not surprising, as it is due to the colloid condition of the particles.[3]

[1] Univ. of Ill. Bull., Vol. 9, No. 36, 1912.
[2] U. S. Dept. Agri., Bu. Chem. Bull. No. 94.
[3] Fellenberg, Ch. Abs., Vol. 9, p. 488.

Mineral Salts

The organic acids of fruits are frequently united with potassium, sodium, calcium and other bases. Besides these the ash shows the presence of small quantities of phosphates, carbonates, sulfates and chlorides. Some have asserted that the iron in fruit is of special value in the food, as it may afford a convenient means of getting this element into the system. It is well known that mineral salts are positively essential for the growth and nourishment of the body, and indeed Bunge has shown that the nitrogenous products of metabolism cannot be eliminated from the body unless mineral salts are present.

STORING, PRESERVING AND CANNING OF FOODS

On account of their perishability many methods have been devised to keep fruits and other foods from one season to another, or to transport them from one climate or locality to another.

Among these methods may be mentioned:

1. *Drying.*
2. *Salting and smoking (applied mostly to meats).*
3. *Sweetening with sugar or honey with or without the addition of spices.*
4. *Preservation in alcohol.*
5. *Pickling with vinegar.*
6. *Packing in fat as suet (for meats).*
7. *Cold storage.*
8. *Sterilization and canning.*
9. *The use of chemical preservatives.*

From the earliest times some of these methods of preservation, such as drying, salting and smoking, preserving with honey and spices, and pickling in vinegar, have been in vogue. These methods have been worked out by various peoples independently as the results of their experience.

Farther than this the art of the preservation of foods did not make much progress until it was understood that decay is due to the growth of low orders of microörganisms as shown by the researches of Pasteur and others. Whatever process will destroy the germs of these organisms, or inhibit their growth, will preserve the food. As these products decay more rapidly in the presence of moisture the foods are dried; as the germs grow better at a moderately high temperature, cold storage is adopted. The temperature of boiling water kills most of the organisms, and therefore sterilization and subsequent sealing to keep apart from a germ-laden atmosphere has become a widely accepted process. It is also proven that the organisms do not flourish in the presence of alcohol, sugar, vinegar, salts, spices or the substances that are present in wood smoke.

In highly nitrogenous foods like meat, game and fish bacteria may readily grow,[1] while the carbonaceous products like fruits and vegetables are especially liable to be the breeding place of yeasts and molds.

PRESERVATION OF FRUIT (DRYING)

In early times the favorite method for preserving fruit was by drying, as the lower organisms do not thrive except where there is at least 25 per cent. of water. A great variety of fruits including apples, pears, peaches, plums, quinces, cherries, raspberries, blackberries, and huckleberries, are still preserved in this way. Some fruits, as cherries and currants, are cooked with sugar before drying.

In drying in a current of hot air the action on the fruit is entirely different from the sun-drying process. The hot air (about 240° F.) coagulates some of the albumin, changes some of the starch to glucose, renders inactive the diastase, and destroys bacteria and other organisms. The current of hot air that ascends through the drier carries so much steam that the temperature is considerably lowered during its passage.

[1] See under Preservative of Meats, etc.

When dried by the old-fashioned domestic methods, apples and other fruits were exposed to dust, dirt, bacteria and flies under conditions that were decidedly unsanitary. To-day, the artificially "evaporated" fruits command a much better price than the domestic sun-dried product, although sun-dried fruit is also a very important product in California. Commercial evaporators did not come into general use in the United States until about 1870.

In the great fruit-growing states like California, New York and Michigan, the fruit-evaporating establishments are built on a large scale and handle great quantities of fruit, but portable fruit driers can be easily constructed and are perfectly practicable either for use on the kitchen stove, or by the use of a special furnace.

Fruit Evaporators

An evaporator may be so constructed that heated air circulates through the chamber containing the drying fruit, or the space may be heated by means of steam pipes. There are three general types of construction in the direct heating system, viz., the cabinet, the kiln and the tower or flue.[1]

The *cabinet* evaporators, in which a set of drawers with screen bottoms is placed above a stove or furnace, are popular with farmers or small fruit growers. In this case the dryest fruit may be placed nearest the source of heat. The *kiln* evaporator is a room with a slatted floor, beneath which hot air pipes are conducted. The fruit to be dried is placed on a slatted platform near the top of the room. One disadvantage of this system is that the fruit must be shovelled over occasionally to insure uniform drying. Good ventilation, of course, is required to carry off the evaporated moisture. *Tower* evaporators are quite extensively used for drying on a large scale. Here a chimney-like building is erected, provided with a furnace in the basement. The tower is provided

[1] G. F. Warren in Cyclo. Am. Agri., Vol. 2. See als o U. S. Dept. Agri., Farmers' Bull. No. 59.

with an endless chain device on which the racks containing the drying fruit are placed. The fresh fruit is charged on the first floor, and the whole series of racks is gradually lifted as new racks are filled. As the trays are removed on the second floor, it is evident that the fresh fruit is exposed to the highest temperature and the steam passes up over the more completely dried fruit. Some believe that a system in which the order of exposure to heat is reversed, so that the driest fruit would be exposed to the greatest heat is more satisfactory. A tower having a capacity of twenty-five trays, each 49×49 inches, will evaporate about 50 bushels of apples per day.

A **cold air** evaporator is in use in which the moisture of the fruit is carried off by a blast of cold air. Calcium chloride is set around the chamber to absorb the moisture. In the *vacuum* process the hot air is let into the chamber and pumped off several times, thus drying the fruit very rapidly.

In most evaporating establishments the fruit is exposed to fumes of burning sulfur, or sulfur dioxide gas (SO_2) before being dried. This is for the double object of bleaching the fruit, that has become discolored by contact with air after slicing and to destroy living organisms. A limited amount of this sulfuring might be allowed, but there is a tendency to use too much sulfur dioxide, and also to use it in "reprocessing" fruit that is wormy and of low grade, to make it appear better and hence more salable. At the present time the United States' standards (F. I. D. No. 76) limit the amount of sulfur dioxide to 350 milligrams per liter, with an allowance of not over 20 per cent. of this in a free state. The fact of the presence of sulfur dioxide in the product should be stated on the label. In Prussia and Saxony the maximum amount of sulfur dioxide allowed is 0.125 per cent.

There is an enormous increase in the amount of dried fruit produced in the United States, within the past ten years. At present the output is more than 500,000,000 pounds annually, of which California produces about 80 per cent.

Preservation with Sugar

As a strong *solution of sugar*, honey or glucose, will prevent the growth of the molds or yeasts, with which the air is usually laden, therefore, a process of sterilizing in sugar syrup has been used, from the time when sugar came into general use. In this process much of the cane sugar, which is present in some fruits (see p. 210) is "inverted" by heating with the acid in the fruit, as is also some of the added cane sugar. This invert or fruit sugar, although not as sweet as cane sugar, is believed to be fully as wholesome as the latter, and probably more easily digested. For preserves, three-fourths of a pound or sometimes as much as a pound of sugar is used for each pound of fruit, but the amount needed varies for different fruits. The fruit need not of course be kept in air-tight jars, unless in a hot climate, but it is better to protect the surface by pouring over it melted paraffin. *Candied fruits* contain more sugar than those which are preserved and belong properly to the class of confectionery.

It is asserted that the antiseptic action of sugar and of salt is due to the ease with which bacteria give up to concentrated solutions of these substances a part of their constitutional elements, enfeebling them so that they have no longer the same capacity for reproduction.

"*Fruit butter*" (apple butter, peach butter, plum butter, etc.) is of German origin. It is made by boiling the fruit either alone or with sugar or spices or with sweet cider, which has been previously concentrated one-half in bulk, to a thick mass stirring constantly to prevent burning. The name "fruit butter" is applied to the product because it is used upon bread in the same way that butter is used.

Jam is a product made by cooking the whole fruit, usually berries, without the addition of water, for half an hour, at the same time crushing them by the use of a wooden "masher." Sugar is then added and the mass is boiled for about ten minutes more.

[1] Eighth Int. Cong. Appl. Chem., Vol. 18, 237.

Adulteration of Jams, Jellies and Preserves

Jams, jellies and preserves are sometimes adulterated by supplying the deficiency in pectose bodies by the addition of some foreign substance to gelatinize and thus improve the appearance of the product. "Agar-agar," gelatin, turnips, vegetable marrow, boiled sago, and similar substances have been used. The use of apple pulp or gooseberry pulp, both of which are rich in pectin, is not so serious an adulteration, as it is only replacing one fruit juice by another. In this case, however, the substitution should be plainly indicated on the package.

If glucose is used its presence should also be stated. Glucose is used in the place of cane sugar because it is cheaper, and not as is sometimes asserted to prevent the cane sugar from crystallizing. Glucose is, of course, wholesome enough, but it has not the sweetening power of cane sugar and is a substitution of a cheap food for a more expensive article. The use of saccharin, which was formerly common in the United States, in this class of goods, is now forbidden by law.

There is no necessity for adding any preservative other than sugar, if care is exercised in the selection of the fruit that is used, and in the process of preserving. Sodium sulfite and sodium benzoate are the preservatives that have come into most general use. There is danger that carelessness in manufacture or bad stock should be more or less covered up by the use of chemical preservatives.

Another adulteration is the addition of coloring matter, very often an anilin color, to correct any deficit from lack of genuine ripe fruit. In fact the commercial jams that were upon the market in the United States, before the passage of the so-called "pure food" laws, were very often entirely artificial, and contained absolutely none of the fruits that the label indicated. The appearance of a berry jam was simulated by the addition of "grass seed," and the product was built up on a basis of apple jelly made from a pomace of doubtful quality.

The food standard of the U. S. Dept. of Agri. is as follows: "Jam, Marmalade, is the sound product made from clean, sound, properly matured and prepared fresh fruit and sugar (sucrose), with or without spices or vinegar, by boiling to a pulpy or semi-solid consistence, and conforms in name to the fruit used, and in its preparation not less than (45) forty-five pounds of fruit are used to (55) fifty-five pounds of sugar."

Marmalade has a texture between the fruit butter and jellies.[1] Sometimes the juice is drained off after cooking as for making a jelly, and the fruit pulp is put through a strainer and cooked with sugar for making the marmalade. Spice is often added to improve the taste of the marmalade if the fruit is lacking in agreeable flavor. Oranges often with the addition of a little grape fruit, lemons, peaches and quinces are especially used for making marmalades.

JELLY

Jelly is one of the most desirable fruit products, because it is the concentrated fruit juice, free from seeds or other waste parts of the fruit, and contains enough cane sugar to give it an agreeable flavor. It is firm enough to retain its shape when poured from the glass container, and yet is not gummy or stringy. This property of gelatinizing has already been referred to (p. 212) as due to the presence in the fruit juice of pectin bodies and organic acids.

A general method of making a jelly is to cook the fruit with or without water, dependent on the kind of fruit used, strain while hot through a moistened cloth, and allow to drain fully but without much pressure. Boil the juice from ten to thirty minutes in a procelain-lined vessel, with frequent skimming, and then while boiling dissolve in it the sugar, previously heated in an oven. The time necessary for boiling after sugar is added, can be known by testing in a spoon a small portion while cooking, or perhaps better by observing how the mass breaks off as it drops from the stirring spoon. Too long boiling or an excess of sugar will cause the jelly to crystallize or it may become gummy.

[1] Anna Barrows in Cyclop. of Am. Agri., Vol. 2.

The making of fruit jelly requires considerable skill, since it is essential in order to obtain a satisfactory product that the proper proportions of pectin, vegetable acid and sugar be maintained. Some fruit juices are lacking in pectin, while others are lacking in vegetable acid. For ordinary fruit juices a proportion of sugar to fruit juice of 3/4 to 1 or 1 to 1 will be found to be correct. An excess of sugar produces a softer jelly and one not having the satisfactory texture. With care a good quality of jelly may be made from a slightly acid fruit by the addition of a small quantity of some vegetable acid as citric or tartaric.[1] Apple juice is often used as the basis of fruit jellies, especially by large manufacturers, and the required flavor is obtained by the use of some other fruit juice, which in itself is lacking in jelly-making qualities.

The housewife has learned by experience that partially ripe fruits are often much more suitable for jelly making than those that are fully ripe, and the juice of a ripe fruit may be mixed with that of another fruit which is partially ripe, as for instance green gooseberries or currants may be mixed with ripe raspberries or blackberries to give excellent results. In domestic practice it has been found that small lots of 1 or 2 quarts of juice can be more satisfactorily worked than larger quantities. When cool the jelly may be covered with glass plates and placed in the sun for a while to complete the process of gelatinizing. When thoroughly set cover the jelly with melted paraffin to protect from the germ-laden atmosphere, and close the glasses with hot tin covers.

FRUIT SIRUPS

A fruit sirup or juice as a basis for a summer beverage may be readily prepared by heating the fruit juice, or even a mixture of several fruit juices until completely sterilized and putting immediately in sterilized bottles, which should be tightly corked and sealed. (See Grape Juice, p. 260.) Occasionally the so-called fruit sirup used at soda fountains and for making non-alcoholic beverages is made with the use of artificial colors and flavors,

[1] Univ. of Ill. Bull., Vol. 9, No. 36.

perhaps sweetened with saccharin, and preserved with sodium benzoate or salicylic acid. All such "compounds" must, in the United States, be labeled so as to show their true composition.

Fruit juices when carefully made are very agreeable and wholesome. They contain most of the mineral salts, acids and sugars of the fruit, with its characteristic flavor. These juices are often prescribed for dyspepsia, and diseases of the liver and kidneys. Fruit syrups differ from fruit juices in containing more sugar.

Fruit vinegars are similar to the fruit juices, and are used to make slightly acid beverages. They are made, usually from berries, by soaking them with vinegar, straining and extracting several times and boiling for a few minutes. They should be preserved in sterilized bottles.

COLD STORAGE

This process has been used very successfully upon fruits as well as upon meats, fish, game, eggs and butter. It should not be forgotten that the life processes go on, although slowly, in fruit, even at a low temperature. The fungi, and bacteria are always ready to produce decay, and their action is only *retarded* by the low temperature. The condition of the fruit when put into cold storage, its ripeness, its soundness and freedom from bruises, all affect its keeping qualities.[1]

During the process of ripening of fruits, which of course takes place to some extent even at low temperature, carbon dioxide gas is given off, and there is usually a tendency for the fruit to increase in temperature. The amount of carbon dioxide evolved is directly reduced by a low temperature, showing that the ripening of the fruit is thus retarded.[2]

By cold storage fruits may be "held over" several months without decaying, and the season during which they can be used may thus be extended. The modern cold storage warehouse has

[1] U. S. Dept. Agri. Bur. Plant Indust. Bull. No. 48.
[2] U. S. Dept. Agri., Bu. Chem. Bull. No. 142.

its ice plant so arranged that cold brine can be circulated in pipes through the rooms in which the fruit is stored. Sometimes, also, the liquid ammonia used for refrigeration is allowed to expand directly in the pipes in the refrigerating rooms, or air previously cooled is circulated through the warehouse. The temperature may thus be reduced to 32° F. or even below and can be accurately controlled. It has been ascertained, however, that for some varieties of apples a lower temperature is required than for others, and in fact there is a special temperature which has been found most satisfactory for keeping each kind of fruit. This is usually, however, from 31° F. to 35° F. The same principle is involved in the shipping of fruit in iced refrigerator cars, and by boats provided with refrigerating apparatus.

It is the general opinion that fruits as well as other produce, that have been kept in cold storage for some time, show a tendency to deteriorate or "go down" very quickly when removed from the warehouse. Fruit stored in cellars or caves at a temperature nearer to that of the outside air does not deteriorate so rapidly when removed to rooms kept at ordinary temperature, as does the cold storage product.

The principal objection that has been urged against the cold storage system is that it affords the opportunity, under certain conditions of the market, to "corner" special products, and hold them until excessively high prices can be obtained. Notwithstanding this danger the advantages of cold storage for the consumer are greater than the disadvantages. A system of public reports to be made each week to the proper officials, giving the exact amount of each product held in cold storage, has been suggested as tending to obviate to a considerable extent the practice of holding for a better market.

CANNING

The greatest advance that has been made in preserving fruits and vegetables is due to the gradual working out of a process of canning. This depends on the simple principle of sterilizing the product by heat, and then protecting it in hermetically sealed vessels from coming in contact with the germ-laden atmosphere.

History

It is said by some authors that this art was practised by the ancient Greeks and Romans, as specimens of preserved fruits seem to indicate, but it was not until 1804 that M. Nicholas Appert, a Frenchman, announced that meat and other organic substances would keep for a long time if sealed in vessels and then heated for some time in boiling water. In 1810 he suggested the method of heating in steam and then sealing so that on cooling a vacuum was produced. Ten years later Daggett and Kensett introduced a modification of this process into New York, for which they later secured a patent. Wm. Underwood & Co. introduced a similar process about the same time in Boston. The chemistry of the process was not well understood, however, until explained by Tyndall, Pasteur and others. The industry gradually grew in importance, stimulated at first by the needs of the "49"ers who crossed the plains, and later by the exigencies of the Civil War.[1]

Conditions to be Met

Yeasts grow rapidly in dilute sugar solutions if there be present enough nitrogenous matter and mineral salts to nourish them, but they do not grow well in a strong solution of pure sugar. Very acid fruits do not afford a favorable medium for the growth of bacteria and yeasts, therefore such fruits as lemons and cranberries do not as readily decay. Most organisms are destroyed by exposure for twenty minutes to a temeprature of 212° F., although there are a few bacteria and some spores that require a higher temperature, or that of boiling water for a longer time. As small fruits can be more thoroughly heated throughout than large fruits, while

[1] Cyclop. of Am. Agri., Vol. 2.

the temperature of 212° F. may be sufficient for the smaller fruits, the larger fruits are often heated in an "autoclave"; a closed vessel in which the temperature may be raised to 240° F. if necessary. It is not necessary to use sugar in canning fruit, and many prefer to add it, when the fruit is served. If desired, however, sugar in amount from one-third the amount of the fruit in very sour fruits, to one-sixth in sweeter fruits may be used. Among the vegetables, corn, peas, beans, pumpkins, beets and sweet potatoes require a high temperature in processing.[1]

Canning in the Household

In domestic practice fruit may be canned in two ways: first, by boiling to fully sterilize, in a porcelain-lined kettle, and then putting the fruit directly into glass or tin cans which have just before been sterilized with hot water, and then closing as quickly as possible; or, second, the fruit may be packed raw into the cans, either with or without sugar, cold water added until the can is filled within about an inch of the top, and the cans then set in a boiler of cold water, each can being loosely protected by its cover. The water is heated to boiling and allowed to boil from fifteen to thirty minutes, dependent on the size and hardness of the fruit; the cans are lifted from the kettle, filled to the top with boiling water and immediately sealed. By placing a wooden rack in the bottom of a wash boiler a number of cans may be processed in this way at one time. This latter method is especially adapted for use in canning peaches, pears, or berries, where it is desirable to preserve the fruit whole and unbroken.

The housewife cannot readily compete with the canning factory in the preservation of some products, as overripe fruits, tomatoes and many vegetables, as at the factory the fruit can be heated under steam pressure, and thus a higher temperature can be obtained than in the home. This is partly obviated in domestic practice by heating the cans for some time on three or four successive days.

[1] U. S. Dept. Agri., Bu. Chem. Bull. No. 151.

Some fruits, as green currants, green grapes, gooseberries or cranberries may be kept, by simply filling the can with cold water and sealing. The tough skin and the acid present in the fruit assist in this process.

Canning in the Factory

Three methods are in use to sterilize the fruit at canning factories. It may be heated in a water-bath, in a bath of some chemical, as calcium chloride, so as to raise the temperature above the boiling point of water or in a bath of steam under pressure. The latter method is the safest, if precautions are taken not to overheat the fruit.

By this method after heating the cans for a time at a temperature always below 250° F. the can is taken out and punctured to allow the air to escape, again sealed with a drop of solder, and again "processed." The ends of the can should be concave when cold and should remain in that shape until they reach the consumer. If there is shown a tendency to "swell" or become convex after some time, this is an indication that fermentation has taken place, and the contents of the can should be condemned.

It has been found[1] that the gases remaining in a tin can above the fruit consist of carbon dioxide, nitrogen and hydrogen, but never oxygen. If the fruit was strongly acid and has been canned for some time, the amount of hydrogen is relatively large.

Sometimes the fruit is cooked before transferring to the cans, then heated in the sealed cans to a temperature of 250° F. in retorts in dry air so as to insure complete sterilization.[2]

Canned fruits, which have stood for some time in tin, and especially "swells," are liable to contain appreciable quantities of tin. The presence of more than 300 milligrams of tin per kilogram in canned products is not allowed.[3] The most recent improvement is the coating of the cans on the inside with a kind of lacquer.

[1] Eighth International Congress of Appl. Chem., Vol. 18, p. 45.
[2] Leach, Food Inspection and Analysis.
[3] U. S. F. I. D. No. 126.

Such cans are especially suitable for those fruits and vegetables most liable to attack the tin.

Chemical preservatives are not generally used in the canning of fruits, although they have been used in vegetables. It is held[1] that if benzoate of soda is used in a food product, it shall not be in quantities above one-tenth of 1 per cent., and the fact must be plainly stated on the label. The canned products of the United States in 1909 were valued at $157,101,000.[2]

NUTRITIVE VALUE OF FRUITS

Although we are familiar with the fact that many of the lower animals practically live on fruits and berries, especially during the fruit season, there has been a prevailing impression that for most people fruit is a mere luxury, to be eaten like confectionery simply for the pleasure derived in the process of eating. The people of the temperate zone seem to forget that the dwellers in the tropics, many of them, practically live on fruit with little else in their diet. Bananas, bread fruit, and cocoanuts are the staple fruits of the tropics. Many persons, on the other hand, use fruit as a medicine, mainly on account of its reputed hygienic value, with no thought as to its real nutritive value.

It is estimated,[3] from a study of the dietaries of more than four hundred families in the United States, that fresh fruits make up 3.8 per cent. of the total food, and supply 2.5 per cent. of the total carbohydrates. To this must be added the dried fruits used, so that all together 4.4 per cent. of the total food material and 3.7 per cent. of total carbohydrates is from fruit. As far as digestibility is concerned 80 per cent. of the protein, 90 per cent. of the fat, and 95 per cent. of the carbohydrates are digested, thus comparing favorably with the digestibility of vegetables.

From some experiments carried on at the California Ag. Experiment Station and elsewhere in which fruit and nuts consti-

[1] U. S. F. I. D. No. 104.
[2] Bu. Chem. Bull. No. 151.
[3] U. S. Dept. Agri., Farmers' Bull. No. 293.

tuted the sole diet of the individuals, the conclusion was reached that it is possible to supply the necessary protein and energy from these foods above, although in many cases the expense per day per capita is greater than with a mixed diet. In this case the protein was derived mostly from nuts and olives and much of the carbohydrates from the fruits.

THE USES OF FRUIT

It is not the intention to discuss here the relative value of vegetable and animal foods, or the claims of "vegetarians" and others, but it is pertinent to say that under the conditions obtaining in the United States, a liberal addition of cereals and vegetables to a fruit and nut diet would decrease the bulk of the food necessary, make possible a greater and more pleasing variety of food, and lower the cost. Fruit is good, but fruit only is bad.

It is of interest to note that in tropical countries fruits grow in much greater abundance and variety than in the north, and in the polar regions practically no fruit at all is grown. Also that the fruit is produced in the temperate zone in the warmer months of the year. These facts point to the conclusion that fruits and vegetables are naturally better adapted for use in warm climates and during the warm season, and animal products where the temperature is lower.

A judicious use of fruit is without doubt extremely beneficial, especially if one conforms in his selection to the particular needs of the system. Usually fruits are somewhat laxative, although some berries, like blackberries, contain enough tannin to act as slight astringents and have a constipating effect. Fine-seeded berries have a constipating and irritating effect, and in that case should be avoided. On this account the fruit juice made into a jelly is a much more suitable diet for invalids than the whole fruit made into jam.

The organic acids of fruits are admirably adapted to assist digestion by increasing the flow of saliva and indirectly of the gastric juice. They also increase the secretions of the liver, pancreas and the mucous lining of the intestines. When taken into the blood the vegetable acids render it less alkaline by combining with the alkaline salts of the serum. In fact the salts of the organic acids are changed to alkaline carbonates. These are some of the reasons why fruits are considered so valuable as antiscorbutics and for use in general debility and anæmia. They are also used to great advantage in gout and rheumatism.[1] Furthermore the natural combination of acids, sugar, pectin, mineral, salts, and water that is found in fruits stimulates the appetite, and helps in the movement of foods through the energy machine that we call the alimentary canal.

Fruits to be wholesome should be ripe. They are often more agreeable when ripened on the tree, although there are exceptions to this statement as in the case of many varieties of apples and pears. If the fruit is unripe any injurious effect can be prevented by properly cooking.

COOKING OF FRUITS

Although it often happens that the cooking of fruits rather diminishes than increases their agreeable flavor yet cooking has many advantages when the process is applied judiciously. On account of the conditions under which fruit is often gathered, stored or sold, its surface is liable to be contaminated with insects, insect larvæ, worms, or injurious bacteria. In some cases it is customary to remove the outer covering before the fruit is eaten, but in the case of berries and some other fruits, this is impossible.

The process of cooking sterilizes the fruit, and protects the consumer, especially from the bacteria on the surface, which might induce disease if taken into the system.

As there is cellulose and starch in fruits, cooking softens and modifies these and renders them better fitted to be taken into the

[1] Foods, Origin, Manufacture and Composition, Tibbles, p. 594.

system. (See p. 10.) Some fruits, as quinces and some varieties of pears, plums and crab apples, are so hard and unpalatable that they are always cooked before they are used.

Frequently fruits and berries are cooked without the addition of water, for they contain about 85 per cent. of water, which simply needs to be set free as "juice" in the process of cooking. In baking apples there is, of course, some loss in weight, due to evaporation, but there is no loss in nutrients, if the juice that exudes is served with the apples.

There seems to be an impression that cooked fruit is sourer than that which is raw. This may be partly due to the physical condition of the cooked fruit, which would allow it to come more intimately in contact with the nerves of sensation. Hot fruit seems to give the impression of sourness more than that which has been allowed to cool, but this may be due to the stimulation of the surfaces with which the food comes in contact. Another reason for this impression of sourness is given by Sutherst,[1] in the case of gooseberries, by the fact that the skins contain more acid than the pulp, and in the cooked portion the skins are included, while if eaten raw the skins are rejected. If cane sugar is present in the fruit, it is changed to fruit sugar (see p. 95) by prolonged cooking in the presence of a vegetable acid, and fruit sugar is not as sweet as cane sugar.

It is often said that fruit is sweeter if the sugar is added after cooking than if it is cooked with the fruit, and although this is theoretically true it has been shown that in the cases tested, although the product is slightly less sweet if the sugar is added at the beginning rather than the close of the operation, the difference is too small to be of practical importance.[2]

OVERRIPE FRUIT

As the fruit becomes overripe it changes in composition, and soon begins to decay. This decay is caused by fungi or molds,

[1] Chem. News, Vol. 92, p. 163.
[2] Jour. Home Econ., 2, 1910, No. 1, p. 94.

which obtain a start most rapidly wherever the skin is broken, or the fruit is bruised. This spreads very rapidly to the sound portions of the fruit, and soon spoils its agreeable odor and flavor, even in the parts not yet affected by decay. As previously noticed (p. 210) with the overripening the fruit begins to ferment; that is, the sugar is changed to carbon dioxide and alcohol.

WASHING FRUIT

It is a common practice with housewives to wash fruits before serving, and experiments have been made which show that the amount of material removed in this process is really quite small. Berries and soft fruits should only be washed just before they are served, otherwise the damp fruit will quickly mold. All the fruit that is vended from stalls or on the city streets is especially exposed to the dust and filth of the street, and to being handled by the often none too clean hands of the vender. It should be as thoroughly washed as is possible. In the case of apples, oranges, bananas, etc., the skin can be removed, but plums, grapes and similar fruits should be washed before being eaten. In many States sanitary regulations are in force to prohibit the sidewalk display of food products, unless they are protected from flies, dust, and other contaminations. Dried fruits such as dates and figs that are eaten raw, should always be thus protected.

CHAPTER IX

ORCHARD AND VINE FRUITS

Although there are not less than one hundred and forty species of fruits known in the United States, not more than forty are grown commercially. It is remarkable to what an extent and how quickly scientific methods have within the last few years been applied to fruit growing in this country. Advanced ideas in regard to spraying, pollination, fertilizing, pruning and intensive cultivation have been very successfully put into actual practice.

ORCHARD FRUITS

APPLE

Following the classification of fruits given on p. 208, the first is the apple (Pyrus malus). This is the typical and in fact the most important of the "pome" fruits. The "core" is the ripened "carpels," as they are called, and the pulp is the thickened "receptacle" on the top of which the "calyx" is borne. Botanically the apple belongs to the same family as the rose, plum, pear, peach and in fact all the more important fruits of the temperate zone.

It is probable that the apple as cultivated in the United States is not a descendant of our native crabs, or wild apples, but comes from the wild crabs of Europe,[1] but important varieties of apples may no doubt at some time be developed from our native crabs. Some excellent varieties of crab apples have already been cultivated.[2] Some authorities believe that both wild and cultivated apples were found in Europe from prehistoric times,[3] while others think they were early introduced into Europe from western Asia.

[1] Farmers' Bull. No. 113.
[2] Origin of Cultivated Plants, De Candolle.
[3] The Evolution of Our Native Fruits, Bailey, L. H.

The chemical composition of apples has already been discussed under fruits (p. 210). The agreeable flavor depends on the right blending of the malic and tartaric acids, with the sugar and pectin properly flavored by valerianate of amyl and other fruit ethers which are present. The following is given by Richards[1] as the average composition of apples. Total solids, 13.65 per cent.; ash, 0.288; acidity expressed as sulfuric acid, 8.73; cane sugar 1.53; crude fiber (cellulose), 0.96. This shows that the apple is little more than flavored water, as 86.35 per cent. is water. Sugar is by far the most valuable and abundant nutrient present. The organic acids present are malic and gallic, which acids are found free as well as in combination.

The dietetic value of apples is regarded as great, and they tend to prevent scurvy and act as a laxative, especially when taken into an empty stomach.[2] It is said that dyspeptics find that the action of the bowels can be satisfactorily regulated by the judicious use of this fruit.

Cooked apples are, however, more wholesome for invalids than the raw fruit, because the small quantity of starch is cooked, and the cellular tissues are softened. When baked, the apple may be eaten with cream and sugar, and thus not only furnish a very agreeable dessert, but one that contains quite a quantity of nutritive material. Apples should be avoided in cases of diarrhœa, diabetes and when there is gastro-intestinal irritation.

Apples, besides being eaten raw and used for cooking, have a very extensive use in the form of dried apples, evaporated apples, apple sauce, apple butter, apple jelly, apple juice, cider, apple brandy, and vinegar, so that the apple, all things considered, is the most used and most valued fruit raised in the United States. The annual apple crop of the U. S, is 250,000,000 bushels.

Unfermented Apple Juice or Sweet Cider

The ordinary method in use among farmers for making cider is to grind the wind-falls and imperfect fruit, and press the

[1] U. S. Dept. Agri., Bu. Chem. Bull. No. 66, p. 41.
[2] Practical Dietetics, Thompson, p. 181.

"pomace" by the use of hand or horse power. This juice is then set aside in barrels and soon ferments. If greater care is taken in the selection of the fruit, and especially in storing in clean barrels, at a low temperature, the fermentation will take place much more slowly. In France[1] much greater care is taken to separate the suspended impurities, and a preliminary fermentation in open vats is given the juice before storage. It is then carefully "racked off" into clean barrels, and thus prepared it keeps well, without so soon developing acetic fermentation and going over into vinegar.

It has been found that it is easy and practical to preserve unfermented apple juice, sometimes called sweet cider, by a simple process of sterilization.[2] It is true that a method still in common use in the United States for preserving apple juice is by the use of benzoate of soda, salicylic acid or sulfites. Many objections may be urged against the use of these chemical preservatives, and it must be said that at best, as ordinarily used, they only retard[3] the process of fermentation, for this ultimately takes place, and alcohol and vinegar finally result, the same as if no preservative had been added.

In the experiment of U. S. Government referred to, it is shown that apple juice can be sterilized in wooden containers at 149° to 158° F. so that it will not change in six months. It is possible before sterilizing to remove much of the insoluble material from the juice by the use of a milk separator. In every case the juice must be carefully protected from the atmosphere after sterilizing.

Cider

Cider, properly speaking, is fermented apple juice, just as wine is the fermented juice of the grape. The unfermented juice or "must" contains on an average[4] 13.39 per cent. of solids, in-

[1] Food Inspection and Analysis, Leach, p. 549.
[2] U. S. Dept. Agri., Bu. Chem. Bull. No. 118.
[3] Kans. Univ. Quarterly, Vol. 6, p. 111.
[4] U. S. Dept. Agri., Bu. Chem. Bull. No. 88.

cluding 10.45 per cent. of sugar. This sugar is of two kinds: viz., 6.84 per cent. of fruit or reducing sugars and 3.48 per cent. of cane sugar. The acidity, in terms of sulfuric acid, is 0.37 per cent. and there is 0.05 per cent. of tannin present.

Of course, the larger the amount of sugar in the juice, the higher will be the per cent. of alcohol formed, as under the influence of certain yeasts found, especially on the outside of the apple, notably the *saccharomyces apiculatus,* sugar is changed to alcohol and carbon dioxide gas.

The cider[1] thus made contains from 2 to 3 per cent. of solids, usually about 0.5 per cent. of invert sugar, 0.30 per cent. of malic acid and a little acetic acid, with from 3 to 6 per cent. by volume of alcohol. If there is over 8 per cent. of alcohol present it is evident that the cider has been "fortified" by the addition of some fermentable sugar so as to raise the alcoholic percentage. "Dry" cider is that which is produced by the complete fermentation of the sugars.

By stopping the fermentation before it is completed the cider still contains 3 or 4 per cent. of sugar, and hence tastes less acid than does dry cider. If the bottles are corked before the fermentation is completed, and champagne methods of treatment are adopted, an effervescent beverage results, and the product is properly called "champagne cider."

A great variety of artificial ciders are on the market which are sold under such names as "champagne cider," "condensed apple cider" and "apple base cider." They are often sweetened with glucose or cane sugar, colored with caramel and preserved with salicylic acid, sodium benzoate, or sodium sulfite. Beverages of this character if taken continuously will no doubt lead to gastric disturbance, and indigestion.

France is the leading cider-producing country of the world, and both there and in Germany millions of capital are invested in growing cider fruit, and manufacturing the beverage.[2] The an-

[1] Local cit.
[2] U. S. Dept. Agri., Bu. Chem. Bull. No. 71

nual cider production of France is from 300,000,000 to 600,000,000 gallons. Cider apples are grown especially in those districts where grapes for the making of wine cannot be successfully grown. A large proportion of this cider is used as a beverage, either bottled directly or artificially carbonated.

Cider differs especially from wine in that it contains malic instead of tartaric acid, and this is not precipitated in the process of fermentation, so the beverage does not improve by the process of "aging" as do most wines.

CIDER BRANDY

Cider brandy, apple brandy, apple jack, is a distilled liquor made by the distillation of cider. It is naturally flavored with the organic acids and ethers of the apple which are carried over with the alcohol in the process. These are not of as agreeable a flavor as those derived from the distillation of fermented grape juice (wine) so the beverage is not as popular. Cider brandy usually contains from 40 to 50 per cent. of alcohol.

VINEGAR

Vinegar as defined under the official standards of the A. O. A C. is the same as cider vinegar, or apple vinegar. It is the product made by the alcoholic and subsequently acetous fermentation of the juice of the apple, is lævo-rotatory and contains not less than 4 grams of acetic acid (CH_3COOH) in 100 cubic centimeters at 20° C.

This fermentation from alcohol to vinegar is brought about by the organism known as *mycoderma aceti*, and may be induced under proper conditions in weak alcoholic solutions from any source. Besides cider vinegar there is found on the market wine or grape vinegar, glucose vinegar, malt vinegar and spirit, distilled or grain vinegar. Wood vinegar or acetic acid, which is made by the destructive distillation of wood, is not allowed for use in any food products in the United States. The special vinegars are considered in connection with the discussion of their several sources.

Vinegar Making

In making cider vinegar the older process is to allow the cider to ferment in the cellar in barrels with open bungholes; a process sometimes requiring two or three years. The addition of old vinegar or "mother of vinegar" accelerates this process. The quick or "generator" process has been largely introduced for making cider vinegar, although it was originally used for making vinegar from malt, beer and spirits. By this process, which requires only two or three days for completion, the dilute alcoholic liquor (cider) is allowed to trickle slowly over beech-wood shavings which are contained in a large cask provided with a perforated bottom. (Fig. 30.) The shavings are previously saturated with old vinegar, thus insuring a thorough exposure of the liquid to the vinegar "plant."

FIG. 30.—Quick vinegar generator, staves removed showing interior. (Hydraulic Press Mfg. Co.)

The same liquid may be pumped up and allowed to flow several times over the shavings until the alcohol is completely changed to vinegar.

This is really a process of oxidation, and air circulates upward over the shavings, thus changing the alcohol, under the influence of the ferment, to acetic acid. There is a notable rise in temperature during the process on account of the chemical action which takes place. The reaction is represented by the equation:

$$C_2H_5OH + O_2 = CH_3COOH + H_2O$$

The vinegar plant only grows in the presence of albuminous substances and certain mineral salts, especially alkaline phosphates. The alcoholic solution should be of 3 or 4 per cent. strength to secure the best results. Too strong an alcohol prevents the action of the ferment.

The adulterations of vinegar are numerous, and vary in different countries, dependent on the kind of vinegar most generally in use. While the common vinegar in the United States is cider vinegar, that of France, Germany and Italy is made from wine or malt; that of England from malt. In addition to these, vinegar is also made from beer, glucose, cane sugar, molasses, rice, corn, rye and the sweet juices of various fruits.

Usually vinegar is adulterated with the object of selling a cheaper article under the name or appearance of a more expensive one. Thus distilled vinegar is colored with caramel to imitate cider vinegar, or it is put on the market labeled "White Wine Vinegar." A dark-colored "grape sugar" is sometimes used as the basis for the manufacture of vinegar, because without any "added color" the product resembles cider vinegar. A weak cider vinegar made from the pomace soaked with water is also sometimes reinforced by the addition of spirit vinegar and sophisticated with apple solids. (See also p. 144.)

MEDLAR (Pyrus germanica)

Medlars are common throughout Europe and the British Isles, but not in the United States. In appearance they are somewhat like small apples and are not edible until they have undergone a peculiar ripening process, induced by the enzymes in the fruit including diastase. This process although suggestive of decay is said to be distinct from it.[1]

PEARS (Pyrus communis)

This fruit also belongs botanically to the Rose order. It is probable that the cultivated pear is derived from the wild fruit

[1] Food, A. H. Church.

that is found all over western Asia and Europe. A great variety of pears have been developed both in Europe and America. They do not differ essentially in chemical composition from apples. Some pears like the Kieffer which are hard and tasteless when gathered, ripen in storage, and after several weeks are soft and juicy. Some varieties like the Bartlett and the Sickle are of special value for canning. On account of the hard insoluble granules found in some pears, they are not as digestible as apples, especially for invalids.

Perry

A strong fermented beverage called perry similar to cider and containing about the same per cent. of alcohol is made from pears. In some parts of the Continent pears are especially grown for this purpose, and the beverage is substituted for champaign cider.

QUINCES (Cydonia vulgaris)

The quince had its origin in the north of Persia[1] near the Caspian Sea, and wild varieties still grow there. This fruit is mentioned by Pliny and Plutarch as a preventive from evil influences, so it was well known even in ancient times. The quince has not been very much modified by cultivation, and is still hard and sour, until cooked. On account of its agreeable flavor when cooked the quince is used for making marmalade and jelly, and as a flavor for other fruits. The seeds are rich in vegetable mucilage, which is used medicinally. It grows readily throughout the temperate regions in both Europe and America. In England it is grown mostly as an ornamental shrub. Wine having a very agreeable taste and odor is made from quince juice, and a mucilaginous drink from the seeds.

DRUPE FRUITS

The drupe fruits consist of one or more hard stones or "pits" surrounded by a thick fleshy layer which is usually edible. Inside

[1] Origin of Cultivated Plants, DeCandolle.

the hard shell there is a kernel which in some cases is edible. This kernel has the taste and odor of hydrocyanic acid and from these kernels this acid can be obtained in small quantities by distillation. The distillate from the bitter almond kernel is exceedingly poisonous.

APRICOT (Prunus armeniaca)

The apricot probably came originally from Armenia and is said to be found wild in the neighborhood of the Caucasus Mountains. It grows readily in warm and temperate climates and ripens earlier than the peach, to which it is closely related. The apricot is extensively grown in China and Japan, in the oases of Africa, in Syria and more recently in California. In the latter state apricots are grown in immense quantities for shipping, canning and drying. Dried apricots contain 30 per cent. of sugars and 2.5 per cent. of free acid. There is said to be quite a market for apricot seeds for use in making "almond paste."

A product known as "*Syrian Apricot Paste*" is extensively used abroad. It is made in a basin, 2 to 3 feet deep, lined with cement. Into this the apricots, after being stoned, are thrown, and mashed or trodden with the feet. The mass is then taken out, spread quite thin on boards and dried in the sun. About 4000 tons is thus produced annually. Some of this is exported to use by manufacturers in making a "jam with apricot flavor." The paste is used in Syria as a substitute for candy; it is also made into a syrup, and is the chief ingredient of many iced drinks.[1]

CHERRY (Prunus cerasus)

The cherry has been improved from the wild cherry of Asia while another variety seems to have originated in the vicinity of the Caspian Sea. It is said that when Lucullus returned to Rome after his victory over Mithridates in the province of

[1] Daily Con. and Trade Rep., 1912, p. 1210.

Pontus, that he brought with him to adorn his triumph a cherry tree, laden with fruit.[1]

Cherry trees begin to bear when four or five years old, and continue to bear to a great age, sometimes one hundred years or more. The composition of the fruit varies greatly with the variety, and the flavor is influenced by the soil and climate, as is the case with apples. Cherries contain on the average 20 per cent. of solids or considerable more than apples, and there is present 11 per cent. of sugar, and 0.43 per cent. acid, expressed as sulfuric, although in reality mostly malic.

More than two hundred and fifty varieties of cherries are grown, some sweet and some sour. In New England, New York, Michigan, Iowa, and especially more recently in California, cherries are extensively grown for market through May, June and July. Some varieties, like the black and white Oxhearts, Tartarian and Bigarreau are admirably adapted for eating, while the sour cherries like the Morello and Early Richmond are better adapted for making sauces, pies and puddings. For the latter purpose the pit of the cherry is generally removed.

Cherries are a favorite fruit for canning either with or without the pits. Sugar may be added if desired. As cherries tend to bleach from the action of the acid on the tin of the can[2] unless the surface of the metal is protected by some kind of lacquer, the addition of some red coloring matter is not an uncommon adulteration. There is, however, no excuse for this form of sophistication, as it does not improve the flavor of the fruit, and the dye when used continuously may be injurious to the health.

A common variety of cherry put on the market is the Maraschino, or more properly the Marasca. This cherry is grown in the province of Dalmatia in Austria. They are prepared by bleaching the fruit in a solution of salt and sulfurous acid, washing thoroughly and then saturating with sugar or glucose and dyeing red or any desired color with coal tar dyes and preserving

[1] Food Products of the World, M. E. Green, p. 229.
[2] Foods and Their Adulterations, Wiley, p. 370.

with alcohol. They are sometimes flavored with bitter almond oil. This product has been so thoroughly "processed" that little of the original cherry remains except the cellular tissue. Large quantities of cherries packed in brine, are shipped to the United States especially from the Balkan peninsula.

"*Cherry bounce*" is a concoction made from sugar and brandy, in which cherries have been soaked. Cherry brandy is made by distillation of fermented cherry juice. A very popular alcoholic liquor, especially among the Germans, is "*Kirschwasser*," which is made by the distillation of fermented cherries. It has the taste and odor of cherry pits, and contains about 50 per cent. of alcohol. *Ratafia* is a similar spirituous liquor, and *Maraschino* is a highly valued liqueur made in Dalmatia from a wild black cherry fermented with honey.

DATE (Phœnix dactylifera)

The fruit of the date palm has been from the earliest times the main dependence for fruit and sugar of the inhabitants of numerous tropical, arid lands. We know that it was grown from the Euphrates to the Nile even before the Christian era, and its cultivation is still largely confined to countries where the climate is similar to that of western Asia and northern Africa.

The Persian Gulf region is at present the center of the date-growing industry of the world. Over 5000 tons of dates have been shipped in a single year from one of the Persian gulf ports, and there are no doubt 20,000,000 date palms in this territory.

The trees may be propagated by seeds or cuttings, but the latter method gives more uniform varieties and is therefore preferred. Irrigation is practised in most of the date-growing regions. The climate is excessively hot, the temperature often remaining at 110° F. for many days and nights.[1] In Africa and the East the dates ripen at the end of August, while in Spain and Sicily they do not ripen until December. (Fig. 32.)

[1] U. S. Dept. Agri., Bu. Plant Ind. Bull. No. 54.

FIG. 31.—The date palm. (By permission, The Central Scientific Co.)

FIG. 32.—Fruit market in Jaffa.

The trees frequently live and continue bearing for two hundred years. The soil where the palms are grown is usually alkaline, for this plant will tolerate more salt in the soil than almost any other. The pistillate and staminate (male and female) flowers are borne on different trees so when the trees are in blossom, the natives climb the pistillate trees and sprinkle the blossoms with the pollen from the staminate trees. The fruit grows in bunches of 20 pounds or more.

To prepare the dates for shipping they must be dried in the sun, as in the preparation of raisins. As some varieties are very sticky, there is every opportunity for filth from the hands and clothing of the Arabs and other natives who gather and prepare the fruit to become attached to the product, and on this account it is suggested that dates be well washed before they are eaten.

Dates can hardly be compared with ordinary fruits as they are so nutritious and constitute so large a part of the staple food of the nations of these arid regions where they are grown. It is said that half a pound of dates and a half pint of milk will make a sufficient meal for a person of sedentary habits. Dates are often pounded and pressed into cakes, and thus prepared constitute the staple "travellers' food" in these desert regions. They are soaked with water befor use, thus softening the cakes and affording a pleasant beverage.

Dried dates, without the stones, as they are prepared for export, contain about 7 per cent. of proteins, 54 per cent. of sugar and 11 per cent. of pectose and gum. Although it has been claimed that an excess of sugar in the diet is injurious, it must be admitted that the Arabs of the desert are among the finest specimens of humanity, with strong bodies and very perfect teeth. Their diet of dates is in some sections supplemented with dried fish or milk, and occasionally a feast of fresh meat. The nomadic habits of these people, and the fact that they live so much of the time in the open air no doubt contribute quite largely to their splendid health.

Experiments in growing date palms in Arizona and California have been made with considerable success.

From the sap of the date palm the Hindoos obtain "jaggery sugar," and palm wine. The latter is made into a spirituous liqueur called "toddy," and also into vinegar. (See p. 113.)

PEACH (Amygdalus persica)

There has been much research devoted to the question of the origin of the peach, and although many have believed that it came first from Persia, there is considerable evidence to show that it was originally grown in China.[1] It is cultivated extensively in the semi-tropical regions of Europe, Africa and Asia, and in many localities throughout the United States.

The peach is readily propagated by its seeds, but the trees thus grown do not produce fruit that can be at all depended upon for quality, so the common method of growing is by "budding" on the native stock.

The peach, when fully ripe, normally contains about 88 per cent. of water, 10.8 per cent. of sugar and other carbohydrates, and 0.7 per cent. of proteins. The flesh of the peach is flavored by the presence of a small quantity of hydrocyanic acid, and fruit ethers. In general there are two kinds of peaches, free stones in which the pulp separates readily from the stone, and "clings" in which the pulp adheres tenaciously to the stone.

As peaches ripen[2] the reducing sugars decrease in quantity and sucrose increases; the amount of acid also increases. It seems to be pretty well established that peaches picked before they are fully ripe, and taken to market in cold storage, do not develop as fine a flavor as those that are practically ripe when picked. The peach season for the consumer is extended by planting early and late varieties, and by rapid methods of transportation from one climate to another, but on account of the perishable nature of the fruit, it must be handled very quickly and carefully or decay will begin.

[1] Origin of Cultivate Plants, De Candolle.
[2] U. S. Dept. Agri., Bu. Chem. Bull. No. 97.

Peaches are regarded as among the most valuable of all orchard fruits for evaporating, preserving and canning. The general methods used for evaporating and canning have already been discussed (p. 213). Lemon and Orange "clings," and Crawfords are the most popular for canning. The canning industry is carried on most extensively in California, Maryland, Michigan and to quite a large extent in twenty other states. Great care is necessary in processing so that the fruit shall be fully sterilized.[1]

The areas in the United States where the peach can be successfully grown are much scattered, as the tree and the fruit are both susceptible to changes of temperature. Peaches are liable to be killed if there is high temperature early in the spring followed by a drop to freezing. It has been found that proximity to large bodies of water so ameliorates the climate that peaches can be successfully grown in those parts of the country that would otherwise be too far north. On this account peaches are grown on the south side of the Great Lakes in New York and Ohio, on the east shore of Lake Michigan, also in the vicinity of the salt water from Connecticut to the Chesapeake peninsula and in Georgia. Another peach-growing area is southern Illinois, Missouri, and Kansas.

The nectarine is often classed as a special variety of peach, or a "sport." It has a smooth skin and characteristic flavor.

Peach cider is made from the fermented juice of the inferior peaches, and when this fermented juice is distilled the product is known as peach brandy, an alcoholic liquor containing about 50 per cent. of absolute alcohol.

PLUM (Prunus domestica)

The plum which is grown in Europe and America is probably a native of Asia, but was brought to Europe hundreds of years ago, and subsequently to America. In addition to the Prunus domestica, there are many varieties of plums which have their

[1] U. S. Dept. Agri., Farmers' Bull. No. 426.

origin from wild species found in other countries. Among these may be mentioned the cherry-plum types which are noticed in southeastern Europe; the Japanese or Chinese plums; the American type as the wild goose plum, sand plum, etc. Among the domesticated varieties especially prized are the Damsons, originally introduced from Damascus, Green Gages and Mirabelles.

Plums are grown in the same way as peaches, and as there is a greater variety, they probably have a wider region of cultivation. They are rich in sugar—the average of three samples of California plums showed 13.25 per cent. of sugar and 21.6 per cent. of total solids. Some varieties contain a large quantity of pectous substances. Plum butter is a favorite form of plum preserves. The Sloe or Blackthorn is a plant of the plum family, which bears a sour, astringent fruit which is utilized in Europe for preserving and for flavoring various liquors.

Prunes

One characteristic of plums is that some varieties may be readily dried to form what are known on the market as "prunes." A plum to make a good prune must contain a large proportion of solids, especially sugar, and must be adapted to drying without the removal of the pit. Formerly most of the prunes were produced in France, Bosnia and Servia, but now the first rank must be given to California,[1] where in 1910 the crop of prunes was estimated as from 85,000,000 to 130,000,000 pounds. This industry has grown up since 1870 when the first commercial orchard was planted.

Three methods for curing prunes are in use: first, sun drying; second, curing in evaporators; third, sun drying or evaporating after the fruit has been partially cooked. The sun-drying method, which is that most practised in California, is the most economical. In parts of California and the Pacific Northwest evaporators are used.

Before being dried the plums must be dipped in boiling lye

[1] U. P. Hedrick, Cyc. Am. Hort., Vol. 3.

or their skins must be pricked to allow the moisture to escape during drying. The fruit is then thoroughly washed and ready to dry or to be placed in the evaporator. When placed in the sun from five to twelve days are required to dry the prune, and in the evaporator from twelve to forty-eight hours. Before cooking, prunes should be thoroughly washed and then soaked in cold water for twelve hours, and then cooked for some time at a moderate temperature.

A form of adulteration practised especially on light colored prunes is to treat them with sulfur fumes. While this acts as a bleach, and improves the appearance, the process should be discouraged as unnecessary and making the fruit unwholesome.

Investigations have been made by the United States Department of Agriculture[1] on the commercial value of the kernels of the peach, apricot and prune. These kernels are quite similar to those of the bitter and sweet almond. From all of these, a fixed oil may be obtained and also a volatile oil. Much of the so-called almond oil on the market is really apricot-kernel oil. The volatile oil of the peach and apricot may readily take the place of bitter almond oil for many purposes.

PERSIMMON (Diospyros virginiana)

The persimmon or "kaki" came originally from Japan and China, and also grows wild in the central and southern part of the United States, and in Mexico. (Fig. 33.) This fruit has only recently received special attention in the United States,[2] although it has for a long time been extensively cultivated in Japan where it has been greatly improved so that now it is from 2 to 3 inches in diameter. The natural fruit is reddish yellow, about the size of a large plum and contains from four to eight seeds. The Japanese Persimmon (Diospyros Kaki) is now grown in the United States in some localities.

There has been more or less prejudice against the persimmon

[1] Bu. of Plant Industry, Bull. No. 133.
[2] U. S. Dept. Agri., Bu. Chem. Bull. No. 141

on account of its astringent or "puckery" taste when not fully ripened. The common opinion is that it must be exposed to the frost before being fit to eat, but this is simply accidental and many varieties ripen fully before the frost comes. The astringency of the persimmon is due to the presence of tannin, a vegetable acid in the unripe fruit, and this is probably changed to sugar in the ripening process.

It had been learned[1] that the Japanese ripen persimmons

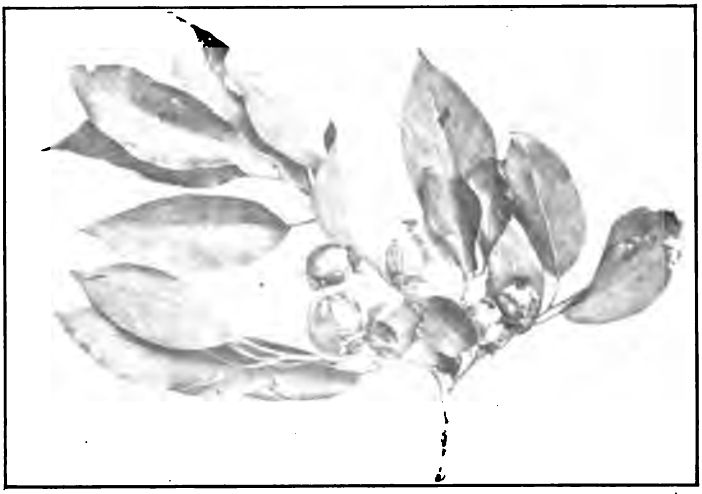

FIG. 33.—Branch and fruit of the wild persimmon tree. (Photo. by C. L. Lochman.)

artificially by placing them from eight to fifteen days in casks from which the native beer, called "saki," has been emptied. A few lumps of starch are placed in the cask to absorb the excess of moisture. Studies on this process revealed the fact that this artificial ripening was due to the presence in the cask of a small quantity of carbon dioxide gas (CO_2). This processing may now be carried out successfully and the astringency fully removed in a short time in an atmosphere of carbon dioxide.

The American persimmon contains 14.5 per cent. of sugars of

[1] Jour. Am. Chem. Soc. 28, p. 688.

which 13.5 per cent. is glucose and the rest cane sugar. The pulp of the fully ripened fruit is sweet and has a fine flavor. By cultivation, no doubt many excellent varieties of larger size, and containing but few seeds, can be produced from the native American persimmon. They may be used for making pies, sauce, puddings, etc. Persimmons dried like figs are exported from China and Japan.

CITRUS FRUITS

The class of citrus fruits includes a number of botanical species, such as the orange, mandarin, grape fruit, pomelo or shaddock, kumquat, citron, lemon and lime. These fruits came originally from China, and other parts of Asia, but were very early introduced into the regions bordering on the Mediterranean Sea, and subsequently into the Western Continent. They may be grown anywhere, where there is sufficient moisture and where the temperature does not fall below 18° F. nor rise above 100° F.[1] The ideal region for their growth is where the winter temperature is not below 26° F., except for a very few hours. The flavor of the fruit is finer if it is grown in the coldest climate where the trees will flourish. In excessively dry regions, if the soil is fertile, citrus fruits are grown with the aid of irrigation.

These fruits are all characterized by a thick peel or rind which is not considered edible, but is utilized for the production of the volatile oil, which is present in abundance. As much as one-fourth of the weight of the fruit is often removed with the peel. The principal acid of these fruits is citric ($C_6H_8O_7+H_2O$). Phosphoric (H_3PO_4) and a little malic acid, are also present and the sugar which is both cane and invert varies within a wide range from less than 1 to over 10 per cent.

The *citron* (Citrus medica, var. acida) is cultivated extensively in China, Persia, the Mediterranean countries and California. It has been suggested that most of the other citrus fruits have been produced by culture from the wild citron. The tree is similar

[1] U. S. Dept. Agri., Farmers' Bull. No. 238.

to the lemon, and bears flowers that are purple without and white within. The fruit is oblong, protrudent at the tip, from 5 to 6 inches long, greenish yellow in color, and very fragrant. The interior consists of a somewhat acid pulp from which a juice is expressed, which is used like lime juice. The rind of the citron, which is thick and spongy, is much used in the preparation of candied or preserved citron. This confection, which contains from 72 to 83 per cent. of sugar, is extensively shipped from Mediterranean ports. This citron should be carefully distinguished from another fruit of the same name, which is really a variety of watermelon, and the pulp of which is also used to make a candied confection.

GRAPE FRUIT

The *pomelo* (Citrus decumana) or *grape fruit*, the largest of the fruits of this family, which came originally from China, is a comparatively new claimant to dietary honors in the United States. It sometimes weighs 10 or 12 pounds[1] and is covered by a rind that is smooth, yellow, and very bitter. It is readily grown in Florida and California, but is still considered something of a luxury on account of the high price at which it is sold. The fruit contains considerable acid, although not as much as the lemon, and also a peculiar bitter principle which renders it quite appetizing to one who has cultivated a taste for it. It has come to be regarded as an extremely wholesome addition to the breakfast menu. The grape fruit is readily grown in the West Indies, and in Oriental tropical countries. The Shaddock, named from a Captain Shaddock who introduced the fruit into the West Indies from China, is the name by which one of the largest varieties of the grape fruit is known in England.

KUMQUAT

The kumquat [cumquat] (Citrus japonica) is one of the smallest of the citrus fruits. It is a native of China, and has been grown

[1] Foods, Tibbles, p. 620.

in the United States for some time. The fruit is bright golden yellow, growing in clusters, and only about 1 to 1 1/2 inches in diameter. The thin rind is sweet and aromatic, and the entire fruit—rind and all—is usually eaten. The tree is exceedingly ornamental when covered with its green leaves and bright yellow fruit.

LEMON

The lemon (Citrus limonum) was introduced originally from eastern Asia, but very early became an important fruit on the shores of the Mediterranean Sea, as this climate was found to be well adapted to its cultivation. Like the orange it grows in subtropical countries where it has an abundance of moisture and a fertile soil. The fruit is gathered, even though still green, when it has reached a marketable size, for if allowed to ripen on the tree it is coarse and of poor quality.[1] The unripe fruit is carefully cured, a process that often requires from 2 to 4 months. It may be kept best in cold storage, at a temperature of about 40° F., unimpaired from 8 to 12 weeks.

The lemon contains less than one-half of 1 per cent. of sugar, and over 5 per cent. of citric acid. It is especially characterized by its essential oil, which is found in the rather heavy rind.

The acids in the lemon occur both free and combined with a base, usually potassium. On account of its composition, high acidity and low sugar content, and because the tough rind protects the fruit so that it will bear transportation and storage, the lemon is used the world over for flavoring, as a relish and for making acid beverages.

"Lemonade," "citronade," or "lemon squash," is a cool refreshing beverage especially suitable for the use of people of a bilious temperament. The alkaline citrates of the juice enter the blood, and are partly oxidized in the system to carbonic acid and water, and partly changed to carbonates. Lemonade should be

[1] Grocer's Encyclopedia, p. 331.

made by rolling the lemon, expressing the juice, and mixing this with the peel cut in slices, a sufficient quantity of water and sugar, and nothing else should be used. There is much fictitious lemonade on the market, which is acidified with tartaric or phosphoric acid, flavored with extract of lemon, and even colored with anilin colors.

The center of the lemon industry is southern Italy and Sicily, where the climate is much like that of Florida and southern California. In Sicily[1] particularly, lemons are grown in great abundance. Before the disastrous earthquake of 1908, Messina was the center of the trade in lemon oil and in the citrate products. It was estimated that the crop of lemons in 1907 in Sicily and Calabria amounted to 6,900,000,000 lemons. About one-third of the crop is used for citric acid, citrate of lime, lemon oil and candied lemon peel.

Oil of Lemon

For the manufacture of oil of lemon[2] the "culls" or small and inferior lemons are used. There are three processes in use for extracting this oil; two so-called "sponge" methods and a "machine" method. In the two-piece sponge method, the lemons are cut in half, and by the use of a spoon-shaped instrument, the pulp is quickly removed. The rinds are soaked for a time with water and then taken to the benches on which are seated the men who express the oil. (Fig. 34.) This work, which is quite laborious, is carried on as follows: A small earthen-ware bowl is placed on the floor between the workman's knees, and across the top is laid a round strip of wood so notched as to fit the widest part of the bowl. The lemon peel is inserted into a cup-shaped sponge, and by pressure of the hand and the use of the stick as a rest, the workman causes the oil to flow out into the bowl; by turning the rind several times, with renewed pressure the process is completed. Two or three pounds of oil per day may be obtained by a skilled workman, and for this labor he receives from 40 to 60 cents,

[1] U. S Dept. Agri., Bu. Plant Ind. Bull. No. 160.
[2] See Chace, Year-book U. S. Dept. Agri. 1908, p. 337-340.

When considerable oil has been obtained on the surface of the liquid, it is blown over the edge of the bowl into another receptacle.

By the machine method of manufacture, which is only used in the province of Calabria, in Italy, the oil is pressed out of the fruit by the use of an extremely crude hand press. The product is more highly colored than that produced by the sponge method, and is used for bringing up the color of pale oils.

Oil of lemon is soluble in strong (95 per cent.) alcohol, and only

FIG. 34.—Expressing Lemon Oil. Two-piece method, as practiced at Mexicali, Sicily. (By permission, U. S. Dept. Agric.)

very slightly soluble in water. The Italian oil contains not less than 4 per cent. of a peculiar flavoring principle called citral, which is chemically speaking an aldehyde, having the composition ($C_{10}H_{16}O$). This substance is found in oil of lemon grass, and may also be made synthetically.

Lemon Extract

Genuine lemon extract is made by dissolving five parts of oil of lemon in ninety-five parts of strong alcohol. For many years more spurious than genuine extracts were on the market in the United States. The alcohol that must be used is really more expensive than the oil of lemon, but a weak alcohol, below 45 per cent.[1] will hold only a trace of lemon oil in solution. To give the extract the appearance of genuineness, however, it is colored yellow with coal tar dye.

A low grade of extract of lemon[2] is made by washing lemon peel with dilute alcohol, whereby the citral, the principal flavoring material, is removed, and the terpenes which constitute about 90 per cent. of the oil remain. This dilute alcoholic solution is the basis of the so-called "terpeneless" extract of lemon. It is true that a little of the lemon flavor is given up when lemon oil is repeatedly shaken up with dilute alcohol, but the extracts so made are frequently worthless for baking purposes. Sometimes these extracts are flavored with "citronella" and strengthened with lemon-grass citral. The standard of the U. S. Dept. of Agric. requires that the terpeneless extract of lemon shall contain at least 0.2 per cent. of citral.

Notwithstanding the large lemon crop of the United States, there were imported, in 1912, no less than 128,840,432 pounds of lemons.

LIMES (Citrus medica acida)

The lime grows in the same regions as the orange and is cultivated especially in the West Indies, Italy, and Florida. The fruit is oval, yellow and not suitable for eating. It is even sourer than the lemon as it contains about 7 per cent. of citric acid, and is most prized on account of this acid, the essential oil and the lime juice which may be obtained from it. Lime juice is used in medicine, and is valuable to prevent scurvy in those who are for long periods deprived of fresh vegetables. Lime juice is often adulterated with other acids, and is preserved with artificial preservatives such as salicylic acid instead of by the natural method of sterilization. The oil or "essence of bergamot" is made from a variety of limes which grows in the province of Calabria in southern Italy.

[1] Food Inspection and Analysis, Leach, p. 740.
[2] Loc. Cit.

ORANGE

The orange (Citrus aurantium) is grown on rather small evergreen trees, and very commonly the trees bear continuously so that both blossoms and ripe fruit are seen at the same time. The thick rind of the orange is admirably adapted to protecting the pulp, and to allow the fruit if not too ripe when picked to be transported long distances. Great skill is necessary to raise a profitable crop of oranges, especially in California and Florida, as conditions of stock, soil, climate, exposure and time of marketing, must all be carefully observed. The trees may be grown from the seed or from cuttings, but the usual method, which insures a much more uniform quality, is by budding on seedling stock.

Oranges contain from 5 to 10 per cent. of sugar, a part of which is sucrose, and a part invert sugar. The amount of acid, reckoned as citric acid, is from 1 to 2 per cent. and the amount of protein is very small. As the pulp contains about 85 per cent. of water, the nutritive value of the orange is not very high, it is however valuable from a dietetic standpoint, on account of its palatability, its mineral and organic salts, and its general influence on other food in the digestive tract.

Most of the European markets are supplied with oranges from Spain, Malta, Brazil, Italy, southern Africa and Florida. The culture of oranges began to be of importance in Florida as early as 1880, and since that time has gradually increased. In 1894–95 the severe weather killed a large number of trees, but the crop has gradually increased since that date. In southern California orange culture began to be of commercial importance about 1880. The so-called "orange belt" covers 1,500,000 acres in this state, and extends from near the sea level to a height of 1800 feet. The trees must be abundantly supplied with water by irrigation and commercial fertilizers are extensively used. Seedless or "navel" oranges were first introduced into the United States from Brazil by Wm. Saunders in 1870. The *Malta or blood orange* was originally produced by grafting the orange on pomegranate stock.[1]

[1] Food Products of the World, M. E. Green.

As the fruit ripens the blood-red flakes extend through [illegible] until frequently the whole mass is red.

Oil of Orange

Although oranges are of the most value for eating raw, they are also utilized for making preserves, marmalade, in which some of the bitter or Seville oranges are used, "orangeade," and the [illegible]. From the rind, dissolved in strong al- [illegible] of orange, which is used for [illegible] by the use of an insuffi- [illegible] is required for U. S. P. [illegible] and artificially colored [illegible] the appearance of being [illegible] as a basis in the [illegible]

[illegible]

[illegible] kid-glove [illegible]. It is a small [illegible] and used in [illegible] and Malta, but [illegible]. The *tangerine*, [illegible] perfumed.

[illegible] furnish such [illegible] imported in 1912, [illegible]

[illegible] temperate [illegible]. From these the [illegible] cultivated grapes have been produced. They are most profitably grown between 55° north and 40° south latitude. The fruit of the vine is mentioned in the earliest Hebrew writings, and the records of wine making in Egypt go back for five or six thousand years.

In Europe they are grown especially in the countries around the Mediterranean Sea, as in Greece, Italy, France and Spain, also in the Canary Isands, Portugal and the Rhine valley. In the United States the best localities for vine culture are western New York and northern Virginia, Missouri, Ohio, southern Michigan and California, but the grape grows well throughout the "corn belt" from ocean to ocean.

History

During colonial times and for some years after, attempts were made to grow European varieties of grapes in America, but without success.[1] Peter Legaux, a Frenchman, started a vineyard near Philadelphia in 1793. In the same year John Dufour, a Swiss, engaged in grape culture in the valley of the Ohio in Kentucky and Indiana, and a large colony of French settlers started a vine and olive colony on the Tombigbee River in Alabama in 1805. It was learned later that the cause of the repeated failures was the fact that foreign grown stock was exposed to various pests such as a tiny plant louse called "phylloxera," and to various mildews, while from native varieties hardy stock could be secured. The first of these to be successfully grown was the Alexander, an offshoot of the ordinary fox grape, *Vitis labrusca*. The Catawba and the Concord were the first of these grapes to be extensively grown in the North and the Scuppernong from the *Vitis rotundifolia* in the South. As European grapes have a higher sugar and solid content than the American species, they are better adapted to wine making, excepting champagnes. They also keep longer and can be used in making raisins. American table grapes, however, are more refreshing and make a better unfermented drink than do the European varieties.

[1] Domestication of American Grapes, Hedrick, P. Sc. Mo., Vol. 82, p. 338.

The quality of the grape is very much influenced by the location, soil, climate and temperature. Indeed, it often happens that the fruit grown in one locality has entirely different qualities from that grown from the same variety of vine in another locality.

The vine is propagated by cuttings or slips which are easily rooted. When it is old enough to bear fruit, it is "cut back" so that only a few shoots are allowed to bear. Sometimes the vines are trained on poles, or racks. In Italy they are often supported by trees which have been trimmed so that they bear very little foliage. Great care is exercised in the vineyards to keep the soil in good condition, and to supply plenty of artificial fertilizers.

The composition of California grapes[1] is: water, 80.12 per cent.; protein, 1.26 per cent.; sugar, 16.50 per cent.; ash, 0.50 per cent. and fat, fiber, etc., 1.62 per cent. Other grapes contain from 15 to 35 per cent. of sugar. Tartaric and malic acid are found in the unripe fruit, but the malic acid disappears as the fruit ripens. The amount of tartaric acid, which is present as acid potassium tartrate and calcium tartrate, is seldom above 1.1 per cent.

On account of the organic acids found in grapes they act as a mild laxative and diuretic. They are of value because they save the nitrogenous tissues, and reduce the nitrogen excretion; that is, like other carbohydrates, they act as protein-sparing substance. Raisins are regarded as excellent food for pedestrians, as they frunish concentrated nourishment and assist in checking thirst. In taking the "grape cure" which is so popular in central Europe, the patients frequently eat from 2 to 8 pounds of grapes per day.

Grapes are utilized principally in some one of the following five ways: 1. For eating. 2. For making raisins. For making grape juice. 4. For making wine. 5. For making brandy. The fruit is readily shipped, if packed in small baskets, over long distances. Attempts to pack ripe grapes in cotton and other absorbents have met with indifferent success. Some varieties of Cali-

[1] Foods and Their Adulteration, Wiley.

fornia grapes are shipped packed in cork chips, but the very best material for this purpose is redwood sawdust.

Raisins

Several special varieties of grapes have been found to be most suitable for making raisins. These are sold under different names: 1. As muscatels[1] or raisins dried on the vines, which include Malaga, Valencia and Denia muscatels. 2. Valencias or dipped

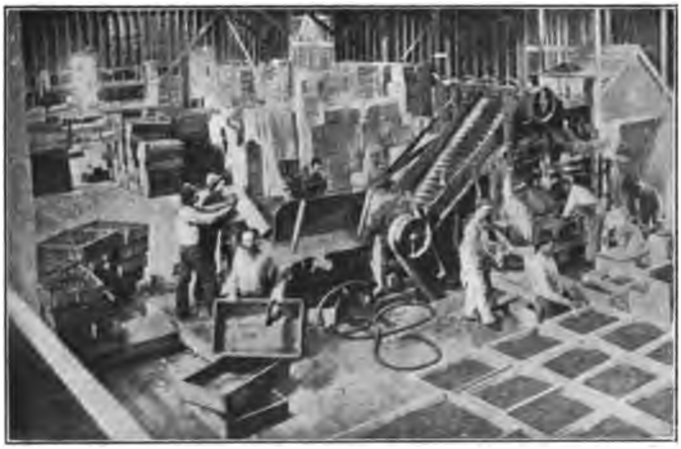

FIG. 35.—Stemming Raisins in Calif. (By permission U. S. Dept. Agric.)

raisins, which include Lexias and Denias from Valencia, Turkey raisins shipped at Smyrna, and California raisins. 3. Sultanas, the small seedless raisins from Greece, Turkey and Persia.

For making the genuine muscatels, the white grapes grown near Malaga are used. When the grapes are ripe, the stem is partially cut or twisted so as to prevent the circulation of the sap, and the fruit is allowed to hang on the vine exposed as much as possible to the sunshine, for two or three weeks. The raisins are then ready, without further treatment, to be packed in boxes for shipment.

[1] Foods, p. 611, Tibbels.

In preparing the dipped raisins, the ripe grapes, with the stems twisted and allowed to hang for a single day to facilitate evaporation, they are pulled and dried in the sun for one day, rinsed with water, and then for an instant dipped in a vat of boiling potash lye flavored with rosemary and lavender, and covered with a layer of olive oil.

The objects of this treatment are to shorten the time needed for drying and to sterilize the fruit. The grapes are dipped by the use of a wire basket with a long handle and are then taken out and exposed in racks, to the sunshine, with frequent turning over. When dry, the raisins are piled in heaps to "sweat," which softens the skin and distributes the moisture more evenly. They are then ready for packing. (Fig. 35.)

Spain sends more raisins to this country than any other land, although Asiatic Turkey is sending a large quantity. California raisins are beginning to take the place of imported stock to quite a large extent. Raisins are also cut open and after the seeds are removed are packed in cartons for household use, or seedless raisins are made from seedless grapes.

The *Zante currant* is really the dried fruit of the small black Corinth grape, which is grown in Greece, and especially on Zante, Cephalonia, Ithaca and adjacent islands. The word "currant" is a corruption of Corinth, at one time a prosperous city from which the fruit was exported. The grapes are dried in the sun, picked from the stalks, cleaned and packed for shipment.

Grape Juice

Before the modern methods for sterilization were understood, grape juice found but little use except for medicinal and sacramental purposes. More recently, however, since the process of sterilization has been perfected, there is an immense demand for grape juice either natural or carbonated, for making a cooling, wholesome beverage. (See Circ. No. 108, U. of Calif.)

Since invisible spores of yeasts, fungi and bacteria adhere to the skins, and stems of grapes, as to other fruits,[1] some means must be devised to prevent the fermentation which these organisms would induce. There are two practical ways of doing this: The first is by the addition of chemical preservatives such as salicylic, sulfurous, boric or benzoic acid, which kill the germs or inhibit their growth. These substances are generally regarded as injurious to health, and their use should be discouraged. The other method of preventing fermentation is by heating the liquid to a sufficiently high temperature to kill the organisms. The lowest temperature that will do this effectively has been found to be from 165° F. to 176° F. At this temperature the flavor of the juice is scarcely changed; but a higher temperature would injure the flavor.

Manufacture[2]

The process of making grape juice is as follows: The clean sound grapes are run through a crusher and stemmer and then directly into steam jacketed kettles. In these kettles are revolving cylinders which keep the crushed grapes continually stirred, while they are being heated to a temperature of 140° F. The heated contents of the kettle is then run into the hydraulic presses beneath, and from these the juice runs into another set of aluminum kettles. Here the juice is heated to 165° F., and skimmed and then run through a pasteurizer at a temperature not lower than 175° F., nor above 200° F. The "must," as it is called, is run directly from the pasteurizer into sterilized 5-gallon carboys, securely corked, and stored in vaults until it has settled and cleared. Afterward the clear juice is siphoned off, filtered, put into bottles, securely corked, and again pasteurized at a much lower temperature than the previous sterilization. Grape juice or "must" prepared in this way will keep almost indefinitely, if stored in a cool dark place.

In domestic manufacture the grape juice, obtained by any con-

[1] U. S. Dept. Agri., Farmers' Bull. No. 175.
[2] U. S. Dept. Agri., Bu. Plant Industry, Bull. No. 24.

venient method, is heated in a double heater, always below 200° F., and then put into a glass or enameled vessel to settle for twenty-four hours. Then carefully pour off the juice, pour it through several thicknesses of flannel, and fill into clean bottles. Set the bottles into water in a large boiler, as for canning fruit (see p. 224), and when the water begins to simmer, take out the bottles and cork securely, and seal with wax.

The composition of the "must" as given by Munson[1] is as follows:

	Concord, from an American grape (per cent.)	California, from a European grape grown in California (per cent.)
Solid contents	20.370	20.60
Alcohol	none	none
Total acids (as tartaric)	0.663	0.53
Volatile acid	0.023	0.03
Grape sugar	18.540	19.15
Free tartaric acid	0.025	0.07
Ash	0.255	0.19
Phosphoric acid	0.027	0.04
Cream of tartar	0.550	0.59

WINE

The making of wine dates from the earliest historical times. Even "Noah planted a vineyard and drank of the wine thereof,"[2] and this beverage was prized by the Hebrews, Greeks, Romans, and later by the Spaniards, French and Germans.

The quality of a wine is dependent not only on the variety of grapes from which it is made, but on the methods of making and storing, locality, soil, temperature and even the weather.

[1] California Expt. Sta. Bull. No. 130.
[2] Genesis IX, 20.

Wine Making

The best wine is made from grapes that are fully ripe.[1] The juice is pressed from the perfect grapes with great care so as not to crush the seeds or stems. Sometimes the stems are taken out by passing the pulp through a "stemmer." Sometimes, the juice is pressed out by "treading." (Fig. 36.) The juice or "must" thus obtained is run into tanks where fermentation is brought about by the action of the various yeasts and other organisms that are present in the juice. One of the most important of these yeasts is

FIG. 36.—Making wine in Madeira.

saccharomyces ellipsoidens, but many other ferments are also found. The fermentation is allowed to continue from one week to several weeks, dependent on the character of the must and the variety of wine to be made, and then the liquid is drawn off from the "lees," and is filtered, clarified, and put into bottles or barrels or vats for storage in cool cellars. Here the temperature is carefully regulated and a second fermentation takes place if enough

[1] U. S. Dept. Agri., Bu. Chem. Bull. 59–72.

sugar remains to induce it, and the wine is greatly improved. White wines are made from the pulp freed from the skins or from the pulp of white grapes. Red wine, if genuine, is colored by the natural coloring matter of the grape skins.

Another process of wine making is to allow the juice to run off from the "marc" or crushed grapes to give the first quality of wine, to press for the second grade, and to steep the pomace with water and press again for the third grade. The "must" constitutes from 60 to 80 per cent. of the weight of the grapes.

In the process of fermentation the grape juice which contains the sugars dextrose and levulose is broken up as follows:

$$\underset{\text{Dextrose}}{C_6H_{12}O_6} + \underset{\text{Levulose}}{C_6H_{12}O_6} = \underset{\text{Alcohol}}{4C_2H_6O} + \underset{\text{Carbon dioxide}}{4CO_2}$$

Dry wines are produced by allowing all the sugar to be fermented so that the wine shall be "dry" or free from fermentable material. These wines are consequently slightly sour. In *sweet wines* the fermentation has been arrested before all the sugar has been broken up by the action of the yeasts. Wines are also divided into the groups "still," or those in which the carbon dioxide gas has been allowed to escape, and "effervescent" or sparkling wines in which a part of the carbon dioxide is retained in the liquid under pressure.

Formation of "Argols"

During the process of fermentation the potassium bitartrate ($KHC_4H_4O_6$), which is present in the must, is gradually deposited in the cask as the amount of alcohol increases, because this substance is sparingly soluble in alcohol. This deposit constitutes the crude "argol" of commerce, which is purified and used as the source of the "cream of tartar" and tartaric acid on the market. One important reason why grapes make a better beverage than apples or other fruit is because of the fact that this salt—the acid potassium tartrate—is deposited as the wine increases in alcohol during storage, and the roughness or harshness is thereby decreased. When other fruits or berries are pressed to obtain a juice, the product thus obtained contains salts of citric, malic and other acids, which are soluble in the alcoholic liquid produced by fermentation and so are not removed by aging. In the process of aging of wine a variety of fragrant ethers such as acetic ether, malic ether, etc., are formed and these produce an agreeable odor or "bouquet," and thus improve the quality of the wine.

Fortification of Wines

If there is sufficient sugar in the must the per cent. of alcohol will continue to increase until it reaches 16 per cent., when the alcohol will inhibit the growth of the yeast and the fermentation will cease. Wines that contain more than this amount of alcohol are considered "fortified," that is additional alcohol has been added. It is claimed by some manufacturers that it is necessary to add more alcohol to wines intended for export to prevent the growth of wild yeasts and the consequent deterioration of the wine.

Composition of Wines

Some of the more common wines on the market have the following composition:

	Alch. by volume	Extractives	Sugar	Volatile acids as acetic	Fixed acids, as tartaric
Bordeaux (claret)........	10.82	2.01	0.12	0.23	0.42
Hock..................	10.91	2.30	......	0.11	0.02
Port..................	21.19	9.20	7.56	0.07	0.34
Sherry................	22.68	3.82	2.25	0.16	0.43
Madeira...............	21.88	4.44	1.85	0.25	0.37
Chianti (Ital.)..........	11.61	....	0.17	0.18	0.60
Champagne............	15.30	3.67	1.92	0.09	0.60
Calif. (red)............	13.00	2.37	......	0.19	0.51

Adulteration of Wines

As wines are so readily adulterated, and misbranded, the fraudulent wines on the market are always numerous. Plaster of Paris is often used in the "marc" or in the must before fermentation, to clarify it, improve the color and make the fermentation more complete. This process leaves some potassium sulfate in solution in the wine, which, if the amount is large, is objectionable. The amount permitted is in some countries regulated by law. Apple cider is often used as the basis for the manufacture of fictitious wines. To this are added such substances as raisins, cream of tartar, elderberry juice for color, fuchsine an anilin color, alcohol, glucose, acetic and other ethers, orris root, and preservatives. The process of "improving" wine by the addition of sugar or glucose is in France called "chaptalizing." In some countries this is not considered an adulteration, unless water is at the same time added.

Varieties of Wine

A few of the important varieties of wine are: Claret, a French wine not very high in alcohol, in which the preliminary fermentation is carried to completion; Sauterne, the most important white wine of France; Sherry, a wine high in alcohol, which is so named from Xeres in Spain, the chief center of the commerce in this variety; Port wine, which is high in alcohol and usually fortified, is named from Oporto in Portugal, the city from which most of it is shipped. Hock is a light, dry wine from the Rhine valley, made from the Riesling grape; Moselle wines are light in quality and come from the valley of the Moselle in Germany. Tokay is a sweet Hungarian wine; Chianti is a light wine produced in Tuscany and northern Italy; Malmsey, produced in the Greek Islands; Madeira and Canary wines are made in the islands bearing these names. They are of delicate flavor and of the Sherry type. Champagne or sparkling wines, which came originally from the Champagne district of France, are matured by three or four years of storage in deep cellars, after which a secondary fermentation produces the carbon dioxide which gives the wine its sparkling or effervescent character. These wines unless fortified, are rather low in alcohol. American wines are similar to the different "types" above mentioned. They are made especially in the Lake Erie region, in Michigan and in California. The use of wine in the dietary is discussed under Alcohol, p. 150.

BRANDY

Brandy is the spirit distilled from fermented grape juice or wine. It is made in most wine-growing countries, but the best known brandies come from France, Spain, Portugal and California. The products of the stills of the Département de la Charente in France, and especially of the town of Cognac have become famous all over the world. Only a part of the "Cognac" found on the market at the present time comes from this province. An inferior brandy is produced by the distillation of a low-grade red wine, or from the "marc," lees, or other refuse of the wine vat.

Distillation of Brandy

A white wine containing 6 or 8 per cent. of alcohol is generally used for making the best brandy. The wine itself is often harsh and not fit to drink. The distillation is carried on in what is known as the "pot still," a large boiler having a bulbous head which collects the scum and some of the water thrown up in boiling. The distillate is condensed by running through a "worm," surrounded by cold water. The process is that of "fractional distillation," and consists of two distinct distillations. In the first operation the distillate is divided into three parts which are collected separately. The first part contains the "crudities" of the wine and is returned to the still; the middle running is the best part, and is used in the second distillation; and the third part or "tailings" is mingled with fresh wine and used in the distillation of the next lot. In the second operation the first lot that comes over is mixed with fresh wine to be redistilled; the second part constitutes the *brandy*, and the "tailings" is used to make a second grade of brandy.

Composition

Brandy, as made in this way, is a colorless liquid, and is only fit for use after it has been "aged" or stored in wooden casks for some years. The color becomes brown from the extractives of the wood, and œnanthic ether, and various aromatic ethers, aldehydes and other products are developed. The propyl, butyl and amyl alcohols, originally present, and all considered injurious, are decreased by this process of aging. A substance known as furfurol is said to be always present in genuine brandy, but it also diminishes in quantity with age. The acidity, which is however slight, increases with age. The per cent. of alcohol in genuine brandy is about 50 by volume.

Fictitious Brandy

A very large proportion of the brandy on the market is not the pure distillate of fermented grape juice. Although brandy should be so defined, it is difficult to hold the manufacturers to this standard. A mixture of neutral or grain spirit, made from a "mash" of corn, rye, potatoes or glucose, diluted with water, and colored with prune juice or caramel, and flavored with "cognac essence," sirup of raisins, rum, bitter almond shells, sugar or tincture of capsicum, is labeled and sold as brandy. Frequently a little genuine brandy is added to improve the flavor. The general method of making the neutral spirit, and the action of alcohol on the system is discussed on p. 150.

CHAPTER X

BERRIES, GARDEN AND MISCELLANEOUS FRUITS

BERRIES

Berries are peculiar in consisting of a mass of seeds, surrounded by a pulp which is often quite watery as in the raspberry, although sometimes firm and solid as in the gooseberry. This juice is often little else than a solution of sugars, pectin, mineral salts, acids and flavoring ethers, frequently highly colored. On this account the juice of berries is the most valuable portion, as the abundant seeds have no food value for man. They act as an irritant in the alimentary canal, and are a frequent cause of constipation, if the berries are eaten freely. The fiber and seed of some small seeded berries, like the blackberry, make up only about 5 per cent., while in the black raspberry it constitutes a much larger percentage.

There is not the evidence of so great an improvement produced in berries by cultivation, as in some other fruits, and flavor is sometimes sacrificed to size. No one will deny, however, that the garden variety of strawberry, black cap, raspberry, and blackberry has many advantages over the wild or uncultivated variety.

A general description of berries has already been given. Most of them with the exception of strawberries are grown on low bushes or small trees. As to their original habitat the blueberries, blackberries, cranberries, currants (red and black), dewberries, gooseberries, huckleberries or whortleberries, mulberries, raspberries (red and black), service berries and strawberries grow wild, many of them over vast areas in the United States. In the Eastern Hemisphere also many of these berries have been known in a wild state from earliest times.

BLACKBERRY (Rubus nigrobaccus)

The blackberry is borne the second year on the shoot which springs from the roots. Cultivation has greatly improved these berries in size and appearance, but the flavor of the native fruit has sometimes been sacrificed by this process. The berries are red before they turn black on becoming fully ripe. They contain from 4 to 5 per cent. of sugar and about 1 per cent. of acid. Blackberries are much used for canning, and making jams, jelly and preserves. Artificial jams and jellies which have apple jelly as a basis and are skillfully flavored and colored and labeled "Blackberry," have been extensively manufactured.

A wine, which is especially recommended for invalids, is made by the fermentation of blackberry juice, with the addition of some sugar. Blackberry brandy may be made by the distillation of the wine. Blackberry cordial is the juice preserved with whiskey or brandy. These products are considered very valuable from a dietetic standpoint.

BARBERRY (Berberis vulgaris)

There are many species of barberry, growing all over the north temperate zone, and in the Andes of South America. It grows wild along the Atlantic coast, and is cultivated in the interior. The shrubs are often used for ornamental purposes, and the elongated, red, acid fruit is utilized for making pickles and preserves.

CLOUDBERRY (Rubus chamaemorus)

The cloudberry is a yellowish sub-acid fruit, having a taste suggesting the tamarind. It grows wild in the extreme northern countries of Europe, especially Scotland, Norway and Lapland.

CRANBERRY (Vaccinium)

This fruit grows on vines or low bushes, some varieties near the seashore and others on uplands, in temperate climates both in Europe and America. A wild variety known as the Preiselbeere is much prized in Europe for making sauce. They have been somewhat, but not very much improved by cultivation. On account of the abundance of the pectose bodies which it contains the fruit is much prized for sauce and jelly. Its rich red color no doubt adds to its value for the decoration of the table. The berry contains 9.90 per cent. of carbohydrates and 2.34 per cent. of acid as malic. On account of the acid and agreeable flavor it is valued to serve as a sauce with meats and poultry. It is one of the few fruits that naturally contains appreciable quantities (0.05 per cent.) of benzoic acid. Cranberries are seldom canned or preserved, as they keep well, and will bear transportation. Cranberries have been recommended for use by patients suffering with gout and chronic rheumatism. This is probably because the alkaline carbonates that are formed in the system from the organic acids stimulate the action of the kidneys. The crop matures in the United States in the late autumn. Massachusetts, New Jersey and Wisconsin are the chief cranberry states, and furnished 653,000 barrels in 1914.

CURRANT (Red) (Ribes rubrum)

Currants, red, black, and white have been somewhat improved by cultivation. They grow well in the northern United States and Canada, but do not thrive in a climate where there is an exceedingly hot sun, or at least they must in this case be protected by other foliage. Currants contain 2.24 per cent. of acid as malic and 6.70 per cent. of sugar. The wine made by fermentation of the juice is a useful beverage in fevers and inflammations. The fruit is extensively used for making sour jams and jellies which are often adulterated, as is the case with nearly all those that are made from berries.

There are several varieties of the *black currant* growing in different countries. The *Ribes nigrum* growing wild in northern Europe is used in the same way that the red and white currants are used. Some of the black currants found in America are eaten, while others, which have a very aromatic flavor, are not utilized. Black currants have secured considerable favor on account of their medicinal action.

Zante Currants (See under Grapes, p. 260)

DEWBERRY

Dewberries are similar to blackberries, and grow wild very abundantly in the United States. They possess a very delicate flavor, often much more agreeable than that of the blackberry.

ELDERBERRY (Sambucus niger)

This berry grows on a small shrub, and is found wild throughout the temperate zone on both sides of the Atlantic. The ripe berries are sometimes used in making pies, but a more common use is for making elderberry wine and a cordial. The juice is also used as an adulterant and coloring material for wines.

GOOSEBERRY (Ribes grossularea)

The gooseberry has been much improved by cultivation, starting with the abundant wild varieties of Europe and America, and some very large berries are now grown. Some varieties of wild berries are thickly covered with spines. The gooseberry is sometimes eaten raw when ripe, but its most common use is for making jam either alone, or mixed with other fruits. Its abundant acid and pectose, makes it especially valuable for this purpose. There is from 1 to 1.5 per cent. of acid in the ripe fruit, and 2.66 per cent. in the skins. In the process of boiling the fruit all the cane sugar is "inverted" by the acid present so it is found as invert sugar in the jam.

MULBERRY (morus nigra) (morus subra)

The mulberry is a fruit which is not very extensively used as food in the United States. The tree is valuable for the lumber produced. The excessive sweet taste of the fruit, without sufficient acid to give a tart taste, is probably the reason why it is not used more generally. The berries of several varieties grow wild on medium sized trees over a large area both in the United States and Europe. The growth of mulberry trees was very much extended in the United States, by the "silkworm craze" which overran the country more than a hundred years ago. A fairly palatable wine is made by the fermentation of mulberry juice and in Siberia a spirit is distilled from it.

RASPBERRY (red) (Rubus strigosus)

The raspberry is one of the most abundant wild fruits or berries of the northern United States, as it grows over a wide area from the Atlantic coast to the Rocky Mountains. It is much improved by cultivation. The fruit is eaten raw and is especially valuable for making jams and jellies. It has a delicate and characteristic flavor which makes it a great favorite for culinary purposes.

RASPBERRY (black) ("black caps")

The area for the successful growth of this berry is more limited than that of the red raspberry. The fruit is improved by cultivation. Black raspberries may be readily preserved for winter use by drying, and they are also canned, and used for making jams and jellies.

LOGANBERRY

This is one of the hybrid plants obtained by crossing the red raspberry and the blackberry. The fruit is reddish black in color, large and luscious, and by many considered superior to either the red Antwerp raspberry or the blackberry from which it was obtained.

HUCKLEBERRY

Whortleberry, Blueberry, Bilberry (Vaccinium)

This berry is found throughout the north temperate zone. There are many varieties of related shrubs growing wild, but they are very seldom cultivated. These berries grow in immense quantities on waste lands in the northern United States and in Canada, where they are gathered by the natives and their sale forms an important addition to the revenue of the people. They are sufficiently hard to bear transportation to distant cities. Some varieties are large and juicy, while others (called "stoners" in the north) are hard and filled with seeds. Some blueberries grow on bushes less than a foot high, while in the swamps are found varieties often 10 feet high.

These berries contain from 76 to 89 per cent. of water, 5 per cent. of sugar, some pectin and from 1 to 1.6 per cent. of free malic and citric acid. Huckleberries may with care be dried so that they will keep during the winter, they may also be preserved by canning. Some varieties make excellent jelly, and the juice is used for making a refrigerant beverage. Huckleberries are specially prized for making pies and sauce.

SERVICE BERRY (Amelanchier canadensis)

The service berry known also as the June berry or Shad berry, is a red to black berry which grows on a medium-sized tree.[1] It may be recognized by its white racemes of flowers in the early spring, and its fruit in the early summer. The tree ranges throughout the eastern United States southward to Florida, and westward as far as Minnesota. The fruit is a great favorite with the birds and squirrels, and has found some use by man either for eating raw or for making into sauce. This is an entirely different tree from the "Service Tree" (pyrus sorbus) of Italy and southern Europe.

[1] Our Native Trees, Harriet L. Keller, p. 153.

STRAWBERRY (Fragaria chiloensis, F. vesca and other F.)

The strawberry, unlike most berries, is in reality a "receptacle," which bears the "achenes" or true fruit on its surface. It grows wild over a large area in Europe, Asia and America from the colder climates on the north to the semi-tropical regions, and has been known from the earliest times. The cultivation of the strawberry began in the fifteenth or sixteenth century, and as a result of the continuous improvement from the native stock in the various countries, a large variety of luscious berries is grown in most civilized lands, where the climate is not too excessively hot.

The plant is propagated by the "runners," which readily take root and for some varieties, by seeds. It needs thorough cultivation and is usually mulched with straw, before the buds start in the spring. Although much has been done to increase the appearance, size and productiveness of the native strawberries by cultivation, the aroma and flavor of the wild berry have not been improved.

Strawberries contain 90.4 per cent. of water, 1 per cent. of protein, 7.4 per cent. of sugar, 1.4 per cent. of pectose, etc., and 1.4 per cent. of acids, mostly malic. This berry is highly esteemed not only for eating, but for making jams and preserves. Adulterated samples of these products are common on the market. One peculiarity of this fruit is, that with some persons who have a peculiar idiosyncrasy, its use produces hives or other symptoms of indigestion, so that these persons are obliged to give up absolutely the use of strawberries. Since this berry needs only a short season for its growth, it can be grown very early in a warm climate and shipped to a colder climate, and late in the season a northern-grown berry can be shipped to the country farther south, so the strawberry season is extended over several months for those living in the temperate climate.

MISCELLANEOUS FRUITS

The agave or American aloe (Agava americana), also known as the century plant, has been cultivated for hundreds of years in Mexico and other semi-tropical countries. The sap or saccharine juice of this plant, when fermented, yields the "*pulque*" an alcoholic beverage much used in these warm countries. The fruit of this plant has no special value. *Octli* is the name of a distilled spirit made in Mexico from the fermented juice of the agave.

AVOCADO (Persea gratissima)

This fruit, known also as the "alligator pear" or custard apple-is readily grown in all semi-tropical countries, and is highly esteemed as a salad fruit, like the cucumber or the green olive.[1] It seems to have come originally from Mexico or South America. The fruit, which grows on a tree from 20 to 60 feet in height, is pear shaped, 4 to 6 inches long, and of a greenish or brownish color. The pulp has a buttery consistency, and is eaten with salt, vinegar and other condiments. This fruit is rich in fat (10 to 20 per cent.) and contains 6.8 per cent. of carbohydrates. Most of the avocados on the market come from Mexico, Cuba, Porto Rica and Costa Rica, but it has been recently shown that it can be readily grown in Florida. Although this fruit is at present sold at a high price, it is believed that when a taste for it has once been cultivated a more extensive demand will make it cheaper and more abundant.

BANANA (Musa sapientum)

To those who live in tropical countries the banana and the plantain (Musa paradisaica), are of nearly as much importance for food as are the cereals to those who live in more temperate climates. A knowledge of the banana belonged to some of the ancient peoples, for it is mentioned by the Greeks, Latins and Arabs, although not by the Egyptians and the Hebrews. One variety (Musa Sapientum), was so named because it constituted the principal food of the Brahmin caste of India.[2] Although indigenous to Asia it is now cultivated not only in the Orient, southern Europe and Africa, but in many parts of Central and South America, and in the tropical islands.

[1] U. S. Dept. Agri., Bu. pl. Ind. Nos. 61 and 67. Bull. 254, Calif. Ag. Ex. Sta.
[2] Practical Dietetics, Thompson, p. 182.

The plant bearing this fruit is herbaceous, and dies or is cut down after fruitage, and new stalks spring from the roots. It is a marvel of productiveness, so that it is estimated that a greater quantity of actual food can be grown on an acre planted with bananas than if planted with wheat, potatoes or any other food-

FIG. 37.—The banana tree, showing flowers and fruit.

bearing plants. The tree grows to the height of from 20 to 40 feet, and the immense bunches of fruit, weighing often 100 pounds, bear from one hundred to two hundred bananas. (Fig 37.)

In the propagation of the tree and for starting a new plantation, seeds are not used, for the fruit practically has none, but shoots cut from the old plants, and these sprout so rapidly that they come to full maturity in ten or twelve months. There are more than one hundred and fifty varieties known, some yellow and some red, but all used for food in the countries where they grow abundantly. For local consumption the fruit is cut before it is fully ripe, but at a time when it is estimated that there is nutriment enough in the stem to supply the bananas until they have fully ripened. If the fruit is intended for shipment to some distance, it must be cut still earlier; in fact while the bananas appear to be very green.

One of the most important and valuable properties of this fruit is that it ripens well after being cut from the tree, so that it will bear shipment and long storage. Fruit steamers, capable of carrying 40,000 bunches of bananas on a single trip, and provided with facilities for cooling and ventilating, have been built especially for the banana trade. By this means the abundant crops of Central and South America and the West Indies are brought in good condition to the European and United States ports.

Composition

The composition of the banana as compared with some other foods is as follows:

	Water	Protein	Fat	Carbohydrates	Fiber	Ash
Ripe bananas (edible portion)[1]	73.10	1.87	0.63	23.05	0.29	1 06
Banana flour[2]	9.70	3.10	0.50	83.40	......	5.30
Dried bananas[3]	29.20	5.30	2.30	55.80	......	5.30
Potatoes (edible portion)[4]	81.30	2.20	0.10	15.70	......	0.90
Wheat flour[5]	12.28	10.18	1.30	75.63	......	. . .

[1] König.
[2] Farmers' Bull. 293.
[3] do.
[4] Bull. No. 43, U. S. Dept. Agri.
[5] Bull. No. 13, Pt. 9, U. S. Dept. Agri. Bu. Chem.

These analyses show that the ripe banana compares favorably with the potato, as far as carbohydrates and protein are concerned. Both are deficient in fat. The analysis also shows that neither of these foods constitutes a well-balanced ration. He who attempts to live on bananas alone would suffer in the same way as the person who attempts to live only on potatoes. (See p. 160.) This fruit is, however, a *food* and should be used as such in the arrangement of the diet. It is not to be classed with such fruits as apples and oranges, although often appearing for dessert on the same plate with them.

A study of the carbohydrates of the ripe and unripe banana pulp[1] shows—

	Unripe fruit	Ripe fruit
Reducing sugars before hydrolysis (as glucose)	0.08	4.21
Increase after hydrolysis (as glucose)	0.15	5.82
Dextrins, etc. (as glucose)	0.50	3.43
Starch (as such)	13.99	0.71
Xylose and other pentoses (as glucose)	2.21	0.75

It appears then that the essential change that takes place during ripening is a change of the starch into soluble carbohydrates, which consist principally of cane and invert sugars and dextrins. Oxygen is necessary for the working of this process. There is also some tannin and mucilaginous substances in the green banana. There is little waste in the ripe banana, as 70 per cent. is edible, and most of the edible material is a sugar which is easily assimilated.

One reason why bananas have sometimes been found to be indigestible is probably because they have been picked too green and are eaten when imperfectly or unevenly ripened. They should be so ripe that none of the mucilaginous quality remains, and the odor that indicates the imperfectly ripened fruit should

[1] J. A. C. Soc., Vol. 34, p. 1729.

be absent. "The banana, especially when *cut* not torn from the stem, is one of the most perfectly sterilized packages of food that appears on the market."

Banana Flour

It is difficult to make a flour from most fruits, as they become sticky or horny on drying, but from certain selected varieties of the banana, and especially from the coarser variety known as the Plantain, at the right stage of ripeness, an excellent flour can be made. This is a fine powder somewhat granular in appearance, and *has a yellowish* color, and agreeable taste. Says Thompson,[2] in discussing the dietetic qualities of this flour, "The finest banana flour called "bananose," at the end of one and one-half hours of pancreatic digestion, was capable of developing twice as much sugar as the same quantity of oatmeal or farina, and approximately one and one-half times as much sugar as cornstarch. Saliva when substituted for pancreatic extract produces a similar effect. Banana flour is made into a thin gruel or porridge by the addition of either water or milk, and eaten with cream it constitutes a delicious and highly nutritious article of diet, suitable in cases of gastric irritability and acute gastritis, etc." Plantain meal, which is made by drying the inside of the unripe fruit, constitutes a staple food in many tropical countries.

41,851,740 bunches of bananas were brought into the ports of the United States in 1912. The European supply comes largely from African colonies.

BREAD FRUIT (Artocarpus communis)

This fruit is a native of the South Sea Islands, and is common in tropical countries. The fruit, which grows on a tree, is the size of a melon, and is as important a source of food to the inhabitants of these islands as are the cereals to those of Europe and America. The bread fruit, according to E. Smith,[3] contains 3

[2] Loc. cit., p. 183.
[3] Foods, p. 206.

per cent. of albumin, 14 per cent. starch and 19 per cent. of gluten and woody fiber. It is roasted and used as a substitute for bread. A paste called "mahe" is made from the fruit and stored away for use during that part of the year (four months) when the fruit cannot be obtained from the tree. This paste ferments and has a disagreeable odor, but after baking it yields a pleasant and nutritious food. Another and more common method of preserving the fruit is to cut it in thin slices and dry in the sun.

FIG. 38.—The fig, showing leaves, flowers and fruit. (Photo, by C. L. Lochman.)

FIG (Ficus carica)

The fig, like the olive, has been cultivated in oriental countries from the earliest times. (Fig. 38.) The fig, the olive and the grape are the fruits most often mentioned in the Bible. It grows wild in the countries around the Mediterranean Sea and toward the east into Asia and westward to the Canary Islands. The trees grow well in semi-tropical latitudes, and this area can be extended toward the colder countries if some protection is afforded the trees during the winter. Two or even three crops of figs are gathered each season in the Levant. In Spain a fig tree in good condition will produce from 150 to 200 pounds of figs per annum, which sell at wholesale for less than $2.00 per hundred.

"Caprification"

A peculiarity of the fig is that the male and female flowers grow on separate trees, so that some method of artificial fertilization is necessary. This is accomplished by the means of insects notably the "fig wasp" (blastophaga grossorum). This process is termed "caprification." It has been the custom from the earliest times to hang upon the cultivated fig-branches limbs of the "caprifigs" or wild "goat figs." These latter bear only male flowers and also contain numerous eggs of the fig wasp. The female insect when she has escaped from the staminate or male flower with her body covered with pollen, instinctively seeks a place for laying her eggs, and finding the Smyrna figs near by, naturally forces her way into the flower-bearing receptacle, and thus fertilizes the pistillate flowers. It is necessary therefore to have enough "caprifigs" grown near the cultivated figs to furnish the pollen.[1]

Curing

Figs are eaten fresh, dried or preserved. Stewed figs are regarded as a staple article of food in the countries where they are grown. Canned and preserved figs are being more extensively used. Among the methods of curing may be mentioned: First, drying in the sun. Second, exposing to the fumes of burning sulfur, so as to sterilize the exterior and destroy spores, fungi and larvæ, and afterward drying in the sun. Third, plunging for a

[1] Ga. Experiment Station Bull. Nos. 61 and 77.

short time into boiling lye, washing and finally drying in the sun. Different methods are practised in various districts and with different varieties. Some are packed in boxes, some in baskets or on strings, and some in mats.

Composition

Fresh figs contain 15.53 per cent. of sugar (dextrose and levulose); 1.52 per cent. of protein, and 79.11 per cent. of water. Dried figs are a more concentrated form of nutriment, for they contain 51.43 per cent. of sugar, 3.58 per cent. of protein and only 28.78 per cent. of water. The sugar is practically the only source of heat and energy, as other nutrients are not abundant.

Large quantities of figs are exported from Smyrna and Adriatic ports, from Greece and Spain. Recently the Smyrna fig has been introduced into southern California, Arizona, Georgia, Florida, Texas and other American states, and is grown very successfully. More than 15,000,000 pounds of figs are annually imported into the United States.

GUAVA (Psidium guajava)

The guava originated in Central America and the West Indies and is now grown throughout tropical countries, and in the United States as far north as California and Florida. The fruit grows on a small tree. There are numerous varieties, both small and large, some round, like an apple, and some pear shaped.

The pulp has an aromatic flavor and is generally made into pastes and preserves. It contains about 80 per cent. of water and 16 per cent. of carbohydrates. The guava jelly, cream, pastes, etc., on the market contain 75 per cent. to 80 per cent. of sugar, and very little acid and are prized on account of their agreeable flavor.

MANGO (Mangifera indica)

The mango originated in southern Asia, and is common in tropical climates especially in the Orient. It is held sacred in India, and references to it are woven through the native folk-lore and poems.[1] The fruit is oval, from 1 to 3 inches in diameter, and grows on an evergreen tree. The ripe fruit, which in tropical countries takes the place of the peach, makes a delicious dessert, or it may be used for making jams, jellies and marmalade. The pulp contains about 87 per cent. of water, 10 per cent. of sugar and 0.6 per cent. of protein. "Mango chutney" is a well-known sauce imported from India. Recently attempts have been made with considerable success to grow the mango in southern Florida It is becoming somewhat common in the markets of the large cities in the United States. The green, strongly acid fruit is boiled with sugar or pickled, and is used in curries and to flavor many fish products.

OLIVE (Olea europaea)

From a study of ancient writings it is evident that the wild olive flourished in Asia in prehistoric times. The cultivated trees were originally grown in Asia Minor, Palestine, Greece and many parts of southern Europe. Most of the olives at the present time are grown in Italy, Greece, France and Spain, and the cultivation is becoming an important industry in Mexico, Central and South America and California. Olive trees were planted at the San Diego Mission in California as early as 1769.

The tree, which is a small gnarled evergreen, with light sage green leaves, (Fig. 39) may be propagated by the seeds, "tips" or suckers, or by layering, but the nursery-man generally prefers to use the tips or small branches which are started as slips. The tree requires good soil and a sufficient quantity of rain, unless those can be irrigation. In the olive orchard great care is exercised to supply the soil with artificial fertilizers, and under the right conditions the trees will continue to bear for a hundred years or more. The climate also must be warm with a mean annual temperature of 57° F.[2]

[1] Phil. Jour. Sci., Vol. 8 A 1, p. 59.
[2] Leonard Coates in Cyc. of Am. Hort., Vol. 3. See also U. S. Dept. Agri. Farmers' Bull. No. 122.

The chief commercial products of the olive trees are the pickled fruit, either green or ripe, olive or "sweet" oil, and the pomace or oil cake which is a valuable cattle food.

Pickled Olives

For making green olive pickles the fruit is picked by hand about six weeks before it would ripen, and is placed in lye, 1 to 2 per

FIG. 39.—The olive; *a*, flower; *b*, *c*, fruit. (By permission U. S. Dept. Agric.)

cent. for some hours, to remove the bitter taste; then it is soaked and washed in fresh water several times and pickled in several brines of increasing strength and finally packed for shipment, in brine that has been recently sterilized by boiling. Olives should remain in this brine for two or three months before they are ready for use. Among the well-known varieties are the olives from California.

Ripe olives have a purplish black color, but their flavor is by many considered superior to that of the green fruit. They are prepared by soaking several times with water, then in strong sterilized brine, and finally in a weaker brine. In some countries dried olives are placed on the market, but they possess a disagreeable astringent taste. Ripe olives may be regarded more as food, while the green olives are, at best, considered only as a relish.

The manufacture and use of olive oil is discussed under Fats and Oils, p. 317.

PAWPAW (Asimina triloba)

This fruit, which grows on small trees, is common throughout the central United States. It is as large as a large pear, and the pulp has an odor and taste suggesting bananas. The pawpaw has never found much favor as a fruit on account of its peculiar taste. The pulp which surrounds the numerous large seeds has a somewhat mucilaginous character.

This fruit is entirely different from the tropical fruit of the same name (Carica papaya). The latter is the size of a small melon, and of a reddish-green color. The juice is remarkable as containing an active proteolytic enzyme, *papain*, which has a powerful influence upon proteins, so that an infusion of the fruit or leaves will, when applied to a piece of tough meat, cause it to become tender in a few minutes.

POMEGRANATE (Punica granatum)

This fruit is one of the earliest known in the history of the world. It is indigenous to Persia and Afghanistan, and is grown throughout tropical countries. Mention is frequently made of it in the ancient religious and mythological writings. The red edible pulp which surrounds the seeds of the fruit (berry) has a sweet sub-acid taste, and is often mixed with water and sweetened to make a cooling beverage. In South America the juice is used to furnish, by fermentation, an intoxicating beverage called "aguardiente."[1]

PRICKLY PEAR OR TUNA (Opuntia)

In various sub-tropical countries as Italy and Sicily, southwestern United States and Mexico, grows a cactus which bears an edible fruit that is much prized by the natives. The varieties grown in other countries are known as Indian fig by the Englishmen, the Barbary fig by the Frenchman, and the "higos chumbos" by the Spaniard.[2] The fruit, which is of the ordinary cactus form, is covered with bunches of fine spines and is of a reddish-yellow or purple color. The outside rind is readily removed and the pulp has a sub-acid taste suggesting that of the cucumber. It contains about 11 per cent. of sugar and small quantities of other nutrients. The fruit bears transportation fairly well, and may be kept for several months. Some of the tuna products that are much used in Mexico are "miel de tuna," a kind of sirup having the thickness of honey, "melcocha" and "quoso," which are concentrated sufficiently so that they crystallize on standing, and dried tunas. A fermented beverage called "colonche," a kind of "present use" beer, is also prepared from the tuna.

PINEAPPLE (Ananas sativa)

This fruit is indigenous to America, and grows especially well in Central America, the West Indies, and Hawaii. It is called "nana" in South America, where the Portuguese called it "ananas." In England it is grown in hot houses, and in Florida on account of the liability to frosts, the trees must be protected by sheds. The trees are propagated by crowns, slips or cuttings. About eighteen months are required to obtain the first crop after

[1] Foods, etc., Tibbles, p. 658.
[2] The Tuna As Food for Man, U. S. Dept. Agri., Bu. Pl. Ind. Bull. No. 116.

setting out the trees. (Fig. 40.) Although this tree grows in quite poor soil, it is necessary to fertilize freely to make a paying crop. The "pines" become ripe even if they are picked when quite green and therefore can be readily transported for long distances, and seem to ripen well under these conditions. The average composition is, total solids 14.17; cane and invert sugar 11.90; acids 0.60. The flavor and odor of pineapples is due to the essential oils and ethers which are present in very small

FIG. 40.—A pineapple ranch, Hawaii. (By permission Central Scientific Co.)

quantities. Canned pineapples are prepared in Singapore and the Straits settlements, and also in the Bahamas, Hawaii, Florida, and other sub-tropical countries. If carefully sterilized, they may be put up without sugar, and thus prepared lose, in the process of canning, very little of their delicious flavor.

Dietetic Value

The pineapple is one of the most valuable of foods from a physiological standpoint. It is considered particularly useful as an aid to digestion, as it contains a proteolytic enzyme called "bromelin," which is closely related to trypsin. This ferment converts albuminous matter into peptones and proteoses, and acts in acid, alkaline or neutral media.

CASHEW APPLE (Anacardium occidentale)

This fruit, to which is attached the cashew nut, is a native of the West Indies. (See p. 333.)

GARDEN FRUITS

The fruits of this class are raised from the seed which is sown annually. The plants are generally vines, and the fruit rests upon the ground as it ripens. Most of these fruits are grown for immediate use, although a few of them like the pumpkin may be kept for winter consumption.

CITRON

This is a small variety of watermelon which is nearly solid, and almost tasteless. It is used for making preserves, which resembles that made from the genuine citron.

CUCUMBER (Cucumis sativa)

This is one of the fruits of the natural order Cucurbitaceæ, or the Gourd family, which appear to be indigenous to southern India, although it has been cultivated from the earliest historic times, in Syria and Egypt. It came into general use in England in the seventeenh century. In Egypt cucumbers are cooked and served in various ways, and form a valuable addition to the diet. In most countries, however, cucumbers are picked before they are ripe, or even in a very immature condition, and are used for making pickles and salads. A prickly variety known as the Gherkin is especially prized for pickling. As the cucumber contains 96 per cent. of water, its food value is hardly worth consideration, but it is useful in varying the monotony of the diet, especially in a hot climate. Cucumbers should be peeled and allowed to stand in cold water for some time before using.

Pickles

The process of pickling with salt and vinegar is applied to many fruits and vegetables such as cucumbers, artichokes, beets, carrots, cauliflower, figs, onions, lemons, peaches, pears, string beans, walnuts, capers and nasturtium seeds. A common method of pickling is to soak the vegetable for some time in brine, and afterward treat several times with boiling vinegar, with or without sugar and spices. Dill pickles are usually large pickles flavored with dill seeds. No less than 3,000,000 bushels of pickles (cucumber) are consumed annually in the United States.

Pickles are adulterated by the use of salts of copper to give them a green color and an appearance of freshness. The author has found an amount of copper corresponding to one-seventh of a grain of crystalline copper sulfate, in a medium-sized pickled cucumber. The use of copper salts for this purpose is not allowed in the United States for goods that enter interstate commerce. Alum is also a common adulterant of pickles. This is added with the object of producing hardness and crispness in the product, and it is asserted in order to assist in the preservation of the pickles. In most of the states of the Union the presence of alum in pickles must be stated on the label.

EGG PLANT (Solanum melongena)

The egg plant, often called the aubergine in England, is indigenous to India, but is a common fruit in the West Indies, southern Europe and throughout the United States. The fruit, which is egg shaped, sometimes white, but more frequently purple, and as large as a cocoanut, grows something like a melon on a vine. As it contains 93 per cent. of water its nutritive value is very low. It is usually prepared for eating by cutting in slices and broiling or frying.

MELON (Cucumis melo)

A study of the origin of melons indicates that they were originally found wild both in India and Africa. They were introduced into China in the eighth century and into southern Europe about the beginning of the Christian era. The French melon, which has a dark yellow flesh, is the variety generally cultivated in Europe. In the United States numerous varieties are grown, including the "musk melon," "nutmeg melon," "Casaba" or winter melon and the "cantaloupe." The latter was named from Cantaloupe in Italy, where it was first grown in Europe. A variety grown under irrigation at Rocky Ford, Colorado, is noted for its delicious taste and odor. The same variety raised from Rocky Ford seeds, is common in other parts of the country.

WATERMELON (Citrullus citrullus)

The watermelon is supposed to be indigenous to Africa, but is now cultivated throughout the central United States and in southern Europe, Egypt and India. The melon grows best on a sandy soil which is well fertilized and in a country where there is an abundance of sunshine. The vines often cover the entire field at the time of fruiting, and the melons have a weight of 50 pounds or more. They are much prized during the warm months, especially in hot countries, for their sweet, juicy pulp. The interior is red or pink, and the seeds, which are numerous, are either white or black.

That the nutritive value of melons is low is shown by the fact that the common melon contains about eighty-nine parts of water and eight parts of carbohydrates, mostly sugar; while the watermelon is still less nutritious, as it contains, in the edible portion, over 92 per cent. of water, and 6.6 per cent. of starch, sugar and similar substances. Watermelons bear shipment very well, but should not be picked before they are ripe. Immense quantities are sent from the southern part of the United States to the north, during the summer months.

PUMPKIN (Cucurbita pepo)

The pumpkin, also a member of the Gourd family, is found in numerous varieties, and often grows to great size. The coarser varieties are used as cattle food and the more delicate kinds are especially prized in New England for making pumpkin pies. Canned pumpkins are convenient to use throughout the year.

SQUASH (Cucurbita)

Many varieties of squashes are cultivated. Both winter squashes and summer squashes are boiled and used as vegetables. As the nutrient material of the squash amounts to about 9 per cent., and that of the pumpkin to only 5 per cent., it is evident that the squash is a more valuable addition to the dietary than the pumpkin.

VEGETABLE MARROW (Cucurbita ovifera)

This is more commonly grown as a garden vegetable in EnglanP than in the United States. One variety, known as the crown gourd or "custard marrow," bears a flattened fruit with scalloped edges, and is sweeter than the true marrow. This fruit is eaten while quite young, and is boiled to prepare it for the table.

TOMATO (Lycopersicum esculentum)

History

The tomato is a native of America, probably either Mexico or Peru. It was formerly known as the "love apple," and was grown only for ornamental purposes. Its Mexican name is "tomatl," while the French still call it "pomme d' amour." Probably on account of the fact that it belongs to the Nightshade family, like the potato and capsicum, and as this family includes many poisonous plants, it was regarded with suspicion as an edible vegetable until about 1850, when it began to be grown and a taste for it was acquired. This is a good illustration of what can be done, and often is done in cultivating the taste for a new variety of food.

Soon after being introduced into Europe, the tomato was grown extensively on the shores of the Mediterranean, where the climate is admirably adapted to its growth. The plant does not flourish in England, as it requires a higher temperature and a longer season than is there afforded. It grows well throughout nearly the whole of the United States.

In order to allow sufficient time for the tomato to fully ripen, the season is usually extended at the beginning by sowing the seed in a hotbed, and setting out the young plants as soon as the danger of frost is past. In southern countries, the tomato is actually a perennial, and can be grown at any time of the year. In Florida and Texas, the plants are started in November, so that the ripe fruit may be put on the northern market in the early spring.

The young plants are set in rows about 4 feet apart in both directions, and as they become larger they may be supported by frames to keep the vines and the growing fruit from the ground. Green tomatoes which are used for pickles, preserves, chow-chow, etc., as well as ripe tomatoes find a ready market. Much has been done in improving the varieties, and the characteristics most desired at present are good flavor, smoothness, even ripening, small and medium size cavities, and thick walls, so as to be suited to long distance transportation.

Composition

The tomato contains about 93 per cent. of water[1] and only 4 per cent. of carbohydrates, including sucrose, dextrose and

[1] Compt. Rend. 145 (131–133) 1907.

levulose. It is interesting as containing free acid as follows: malic 0.48, citric 0.09, oxalic 0.01, with traces of other organic acids Much of the nutritive material is found in the juice, therefore too much of this should not be left out in canning. The seeds may be strained out, and the pulp and juice only used in cases where the seeds are considered irritating to the alimentary canal. Some physicians have objected to the use of the tomato in cases of gout or uric acid diathesis on account of the oxalic acid which is present.

Canned Tomatoes

As the tomato retains its flavor so well after canning, and as this flavor is so universally liked, after a taste for it has once been cultivated, the demand for canned tomatoes in the United States has become enormous. They are used as a flavor or soup, or directly with the proper seasoning for numerous varieties of prepared food. No canned vegetable except corn is so much in favor.

In the process of canning, the skins, cores, and unripe portions should be rejected. The sealed cans are sterilized by being allowed to remain in a bath of hot water or brine for a sufficient length of time. Experience has taught the packer how much time and how high a temperature is necessary for this process. Just as with other canned fruits, lack of care in the preparation will be shown by a high per cent. of "swells," which indicates that fermentation is taking place.

There is little excuse for the adulteration of canned tomatoes, and at the present time chemical preservatives are seldom found. Even the use of coal tar colors, or cochineal to cover up the fact that unripe and imperfect fruit has been used, is practically a thing of the past. The most common fraud in canned tomatoes is probably the use of too much water in the product.[1] In some states legal standards for the weight of the solid fruit have been fixed, as for instance, the "Fancy" grade must contain not less

[1] Bulletin N. Dakota Ag. Ex. Sta., Vol. 1, p. 240; p. 300.

than 20 ounces of fruit per can, and the "Standard" grade not less than 18 ounces of ripe fruit exclusive of juice. Cans have been examined which contained as low as 7.1 ounces of solid fruit. Over 150,000,000 cans of tomatoes were put up in the United States in 1909.

Tomato Ketchup (Catsup)

This condiment, which is so universally used in the United States, demands more than a passing mention, especially since it has attracted much attention from being one of the fruit products that was formerly preserved by the addition of chemicals, especially sodium benzoate and salicylic acid. The standard for tomato ketchup as adopted by the Association of official Agricultural Chemists is as follows: "Ketchup is the clean sound product made from the properly prepared pulp of clean, sound, fresh, ripe tomatoes, with spices, and with or without sugar and vinegar."[1] There is no mention made of the use of preservatives or coloring matter in this standard, and many manufacturers claim that with carefully selected material, cleanliness in handling, and thorough sterilization in the bottle, no preservatives are needed. In some states one-tenth of 1 per cent. of sodium benzoate is tentatively allowed. When this statement appears on the label it often happens, however, that the amount stated is actually greatly exceeded.

It was formerly the custom in some cases, in making tomato ketchup, to use the refuse and skins of the canning factory, sometimes badly fermented, and to sweeten with saccharin, color with coal-tar colors, and use a liberal amount of chemical preservatives. In the best grades of ketchup, however, none of these practices are now allowed. A bottle of ketchup should, after being opened, be kept in the ice chest when not in actual use. F. W. Robinson says, "For the consumer, it is far better that the ketchup should ferment and thus not be consumed by him, than that an unwholesome, unclean product be taken into the system."[2]

[1] U. S. Dept. Agri., Bu. Chem. Bull. No. 119.
[2] Association State and National Food and Dairy Depts., 1907, p. 143.

Tomato Paste

One of the important food products exported from Italy to the United States is tomato paste. This is flavored in various ways and used as a condiment. *Chili sauce* has for its basis pulped tomatoes and is flavored with red peppers, onions, vinegar and spices. It contains the seeds of the tomatoes, in this way also differing from tomato catsup.

Tomato Seeds

The extraction of oil from tomato seeds was first attempted by a firm in Parma, Italy, in 1910. This is used especially in the manufacture of soap, and it may be ultimately utilized as an edible oil. One hundred and fifty metric tons of tomato-seed oil were produced here in 1912.[1] (See p. 323.)

[1] Daily Consular Trade Rep., 1913, p. 954.

CHAPTER XI

FUNGI (MUSHROOMS), LICHENS, AND ALGÆ USED AS FOOD

MUSHROOMS

The fleshy fungi known as mushrooms have been used as food since the time of Pliny and perhaps earlier. In the vicinity of Paris mushrooms have been cultivated since the sixteenth century.[1] There is an erroneous opinion prevalent that all poisonous fungi belong to the class called "toadstools," while the edible varieties are classed as mushrooms.

The Agaricus campestris (Fig. 42), which is common in the United States and Europe, consists of a centrally placed stalk from 2 to 6 inches in height, in the end of which is borne a cap-shaped portion known as the cap. The color of the plant varies from white to brown and on the cream or white stem a short distance below the cap is borne a ring or "annulus." On the under surface of the cap are numerous "gills." Between these folds is a blackish-brown powder which consists of innumerable purple cells, termed spores, which take the place of seeds and serve for the reproduction of the mushroom. Each spore is capable of germination and will produce a thread-like growth in the soil. This is called the spawn or more properly the "mycelium" of the mushroom and is what is sown in beds. On these threads are subsequently formed little nodules which are the earlier stages of the growth, and with favorable rains the mushroom grows from these nodules almost in a single night. Mushrooms differ very much from ordinary green plants, for there are really no roots, stems or leaves.

[1] U. S. Dept. Agri., Farmers' Bull. No. 204.

Mushroom Growing

The mushroom industry has been more fully developed in France and England than in the United States. The best place

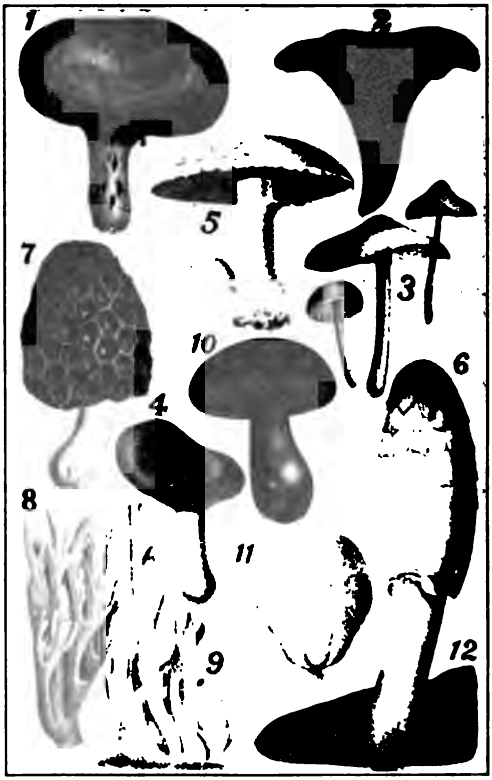

FIG. 41.—Twelve edible mushrooms, common to the United States. 1. Lactarius delicious Fr. Orange milk mushroom. 2. Cantharellus cibarius Fr. Chantrelle. 3. Marasmius oreades Bolt. Fairy ring champignon. 4. Hydnum repandum L. Spine mushroom. 5. Agaricus campestris L. Meadow mushroom. 6. Coprinus comatus Fr. Maned Agaric. 7. Morchella esculata P. 8. Clavaria cinerea Bull. 9. Clavaria rugosa Bull. 10. Boletus edulis Bull. Edible pore mushroom. 11. Lycoperdon giganteum Batso Puffball. 12. Fistulina hepatica Fr. Liver fungus. (Report, microscopist, U. S. Dept. Agric. By permission.)

for a mushroom bed is a cave or cellar, or a bed that can be closed and covered more for the purpose of regulating the temperature than to shut out the light. The proper temperature for growth ranges from 53 to 60° F. Abandoned stone quarries or coal mines have been utilized for mushroom growing, but the beds must be so arranged that they are well drained. The beds are constructed of well composted stable manure, and in this the spawn is sown. Beds will come into bearing within eight weeks after they are sown, and often continue to bear for two or three months. The propagation of the spawn or "bricks" used for seeding the beds

FIG. 42.—Common Mushroom, *Agaricus campestris*. Edible.—(F. V. Coville, Circular No 13, Division of Botany, Department of Agriculture.)

requires considerable skill and careful attention to the conditions of temperature and moisture.

Composition of Mushrooms

Notwithstanding much that has been written by enthusiastic mushroom lovers about the value of these fungi as a food product, the chemical analysis does not sustain this opinion. Comparing the different varieties it will be seen that the general composition is as follows:[1]

Water 89 per cent. to 92 per cent.; total nitrogen 0.15 per cent. to 0.60 per cent; albuminoid nitrogen 0.15 per cent. to 0.37 per

[1] U. S. Dept. Agri., Farmers' Bull. No. 79.

cent.; non-albuminoid nitrogen 0.12 per cent. to 0.30 per cent.; protein 2.25 per cent. to 3.75 per cent.; fat 0.20 per cent. to 0.50 per cent.; carbohydrates 1.4 per cent. to 3.5 per cent. Beefsteak with which mushrooms have sometimes been compared, contains on the average 19.50 per cent. of protein and 17 per cent. of fat. In mushrooms from 30 per cent. to 40 per cent. of the nitrogen is not available as food, being in the form of amides or other non-protein bodies. That they often have a meaty flavor and like the "extractives" in meat excite the gastric activity is not denied, but they cannot be compared to meat in their nutritive constituents.

FIG. 43.—Amanita mellæ. An edible mushroom. (By permission E. A. White, Cf. St. Geol. and Nat. Hist Survey.)

As fungi grow without chlorophyl, they cannot utilize the carbon dioxide of the air to build up carbohydrates, but must in their place take up some complex organic bodies. They contain no starch, although glycogen, sometimes called animal starch, is found in "truffles"; the sugars present in mushrooms are mannite and trehalose,[1] and several enzymes and organic acids are also found.

[1] Foods, Origin, Manufacture and Comp., Tibbles, p. 578.

In the process of cooking, the mushroom shrivels considerably, and loses some of its extractives, thereby losing some of its flavor. As it absorbs water at the same time, the final result of cooking is that stewed mushrooms contain only about 2 per cent. of solid matter.[1]

Digestibility

Mushrooms are not readily digested in the stomach. This may be partly due to the peculiar character of the cellulose, which seems to become somewhat coagulated and "leathery" during cooking. Furthermore Mendel has shown that considerable of the protein, and most of the cellulose is undigested. It seems evident then that in nutritive qualities or in digestibility, mushrooms do not compare favorably with either green vegetables or with meat and eggs.

Poisonous Mushrooms

There seems to be no rule by which the ordinary consumer, unless an expert, can distinguish between edible and poisonous mushrooms. Practically the only safe way is to purchase those mushrooms that have been cultivated and are known to be edible. Canned mushrooms, since they are put up by those who are familiar with the business, have very seldom produced any injurious effects. It is well to be cautious about deciding on the quality of wild mushrooms, by following any published "rules" for their selection. Gibson, one of the authorities on mushrooms, says, "Avoid every mushroom having a cup or suggestion of such at the base; the distinctly fatal poisons are thus excluded; exclude those having an unpleasant odor, a peppery, bitter or other unpalatable flavor, or tough consistency; exclude those infested with worms or in advanced age or decay." (Figs. 44, 45.)

The symptoms of mushroom poisoning are exceedingly varied,

[1] J. C. Soc., Vol. 61, p. 227.

since there are numerous poisonous varieties and they contain different harmful ingredients. In general the symptoms are vomiting and diarrhœa, followed in some cases by stupor, cold sweat and weak heart action. One peculiarity is that with some poisons the symptoms appear shortly after eating the mushrooms, and with others perhaps not until twenty-four hours have elapsed. In some cases of poisoning the alkaloid atropin has been given with success by physicians to stimulate the action of the heart.

FIG. 44.—Fly Amanita. (Amanita muscaria.) Very poisonous. (By permission E. A. White, Cf. St. Geol. and Nat. Hist. Survey.)

Among the poisonous principles of mushrooms may be mentioned amanatin ($C_6H_{18}NO$), and phallin, and the active principle muscarin, ($C_5H_{13}NO_2$), which is so poisonous that 0.003 of a gram will cause serious symptoms in a human being.

Varieties of Edible Mushrooms

Some of the edible mushrooms most frequently used are those shown in Figs. 41, 42 and 43.

The common, horse, fairy ring, and puff ball are among the abundant mushrooms of the woods and fields in the United States and England. The Blewitz, scaly capped, shaggy, and boletus are common on the Continent.

FIG. 45.—Deadly Amanita (Amanita phalloides), very poisonous. (By permission E. A. White, Ct. St. Geol. and Nat. Hist. Survey.)

The "Morel" is a mushroom having a hollow stalk and conical pitted cap. They are exported in a dried condition from Germany, and are especially used as a flavoring for soups, sauces and gravy. The term "champignon" is applied in France to the Agaricus and frequently to mushrooms in general.

Truffles

"Truffles" are underground fungi found growing wild, especially in England, France and Italy. They were known as early as the fourteenth century, and have always been much prized for their flavor. They seem to grow best in the shade of nut-bearing trees, and are propagated by spores like mushrooms. The truffle grows just beneath the surface of the soil to about the size of a potato and may be red, white or black. The most famous variety is the Périgord Truffle which is named from the French province, where it is found. In England dogs are trained to find the truffles, while on the Continent hogs are taught to discover them by the peculiar fleshy odor which they emit. They are used for garnishing dishes, and in flavoring soup and gravy, their value depending on their size, aroma and texture.

Preservation of Mushrooms

A common method of preserving mushrooms is by drying. They may be strung on a string by means of a needle, and dried in the sun, or over the stove, and when needed for use they are soaked in cold water. Large quantities of dried mushrooms are exported from Europe. Another method of preservation, especially in Russia, is by packing in salt and vinegar. In France the canning of mushrooms has grown to be an important industry, the young or unexpanded form, known as "buttons," being mostly employed. Before they are canned, mushrooms are often bleached by subjecting them to the fumes of sulfur dioxide. The imperfect fungi are also canned and sold for use in soups, etc., under the name "Champignons d'Hotel," which is understood to mean "buttons and pieces." "Mushroom catsup" is made by sprinkling the fungi with an abundance of common salt, and afterward boiling the juice with spices, and adding this to the chopped mushrooms, which have also been boiled.

Statistics

Most of the mushrooms imported into the United States come from France, with smaller quantities from Japan, Russia, and Germany. The total quantity imported for the year ending June 30, 1911, was 6,656,657 pounds.

ALGÆ

Under the term algæ are included several varieties of seaweed, which are used as food. The most important of these is Irish moss or Carrageen, which is used both as ordinary food and in the dietary of invalids. It is abundant on rocky shores, especially those of Ireland, and grows from three-quarter tide to below low water mark. Several species of this seaweed are used. They are boiled for several hours until a slimy pulp is obtained, and this is sometimes made into cakes with oatmeal and fried in butter, or with vinegar and pepper is made into a sauce.

Composition

The chief constituent of Irish moss is a kind of mucilage which is known as "lichenin." The dried moss has been found by Church to contain 9.4 per cent. of nitrogenous matter and 55.4 per cent. of mucilage. As this mucilage is not affected by the saliva or pancreatic juice, and as the nitrogenous matter is not all of the digestible class, there is considerable question as to the nutritive value of this material.

Other edible algæ are the alaria or "murlins" of the north coasts, the dulse of the Scotch and Irish coast which forms a welcome addition to the potato diet of the peasants, and the agar-agar or Chinese gelatin of the Orient. The edible birds' nests which find so much favor with the Chinese are formed by the swallow from gelatinous seaweeds, which are disgorged by the birds in building their nests.

LICHENS

The most important edible lichen is Iceland moss. It grows abundantly in the Arctic regions, and is sometimes made into bread or boiled with the milk of the reindeer. The bitter principle (acid) which the moss contains is partially removed by soaking in a weak solution of sodium carbonate. The jelly-like substance obtained by boiling the Iceland moss with water consists largely of lichenin or moss starch $(C_6H_{10}O_5)_n$ and iso-lichenin. Although these substances are only slightly affected by the ordinary digestive juices, this moss must afford some nutriment, as it is an important food of the Laplanders and of their reindeer.

CHAPTER XII

ANIMAL AND VEGETABLE FATS AND OILS

Fats and oils may be divided into two general classes:

1. Essential or volatile oils.
2. Fixed oils and fats.

The essential oils are entirely different in their composition and properties from what are ordinarily known as oils. They are volatile constituents of plants, and may be driven off unchanged by heat. As they are important constituents of Spices, a more complete discussion will be found under that head. (See p. 440.)

Fixed oils or fats are from two sources, viz: animals and vegetables.

Many of these substances are important constituents of foods, while others, differing only slightly in chemical composition, are utilized in various industries, such as the making of soap, candles, paints, etc. Many of the animal oils, such as whale-oil, seal-oil, and fish-oil, are not agreeable to the taste of civilized people, but most of the vegetable oils,[1] if properly refined, make good food products. Vegetable oils are most frequently found in greatest abundance in the seeds of plants, and are extracted by pressing the ground or crushed seed, or by extracting with some solvent like gasoline. Animal fats on the contrary are obtained from the animal tissues by a process of "rendering," or heating until the fat is melted, so that it can be separated from other animal matters.

Composition

Considered chemically, fats are glyceryl esters of fatty acids, or they may be looked upon as salts of the higher saturated or

[1] Chem. Tech. and Anal. of Oils, Fats and Waxes, Lewkowitz, p. 913.

unsaturated fatty acids in which the glyceryl acts as the base. Just as nitric acid when treated with caustic soda forms water and sodium nitrate (Chili salt peter), so stearic acid will theoretically combine with glyceryl to give glyceryl stearate (ordinary stearin). Some of the fatty acids contain a relatively higher proportion of hydrogen than others; those to which more hydrogen can be added we term *unsaturated*, while those that are fully supplied with hydrogen we speak of as saturated. To the former class belong oleic and linoleic acids, and to the latter stearic, palmitic, arachedic acid, etc.

Ordinary tallow is a mixture of stearate of glyceryl, $(C_3H_5\text{-}(C_{18}H_{35}O_2)_3$, with palmitate and oleate of glyceryl. The physical condition of the fat or oil, *i.e.*, whether it is a solid or a liquid at ordinary temperatures, depends largely on the relative proportion of the saturated and unsaturated glycerides present. Fats containing a greater proportion of the palmitate and stearate are solid; while those with a predominance of oleate are liquid.

Treatment of Unsaturated Glycerides

Recently a practical commercial method has been discovered[1] for saturating the unsaturated glycerides by merely heating them with hydrogen in the presence of some catalytic agent such as nickel, so that now we have, instead of the liquid cotton-seed oil which is high in glyceryl oleate and low in the stearate, a white solid similar to tallow in which a considerable quantity of the oleate is changed to stearate. This change may be represented by the equation:

$$\left(\underset{\text{Oleic acid}}{C_{18}H_{34}O_2} + 2H = \underset{\text{Stearic acid}}{C_{18}H_{36}O_2}\right)$$

The work of Sabatier and Senderens has greatly advanced the processes used in the hardening of fats. The catalyzers used are of the two classes of metals, those of the nickel group and those of the platinum group. These when in a finely divided form are

[1] J. Soc. Ch. Ind., Vol. 31, p. 1115.

very active in hydrogenizing fats. In the process a small amount of the metal is introduced into the fat, which is at the same time heated in a current of hydrogen to a temperature of from 100° C. to 225° C. The metal used is, after the completion of the hydrogenation, removed by filtration.[1]

Saponification

When fats or oils are "saponified" by treatment with an alkali, as in the manufacture of soap, a potassium or sodium salt is formed, and commercial glycerine remains in the mother liquor, from which it may be separated and afterward purified by vacuum distillation.

VEGETABLE AND ANIMAL FATS

Vegetable fats usually contain more of the unsaturated, and animal fats more of the saturated glycerides. On this account the animal fats are more frequently solid and the vegetable fats are more often liquid, in which case they are known as oils. The liquid condition of the vegetable oils is rather an advantage than otherwise, as far as ease of digestion is concerned.

In the extraction of the fat or oil from the animal or vegetable tissue, it is difficult to avoid obtaining other substances which are not oils. These impurities are mechanically mixed, and therefore most oils must be purified and refined before they are fit for use as food.

ANIMAL FATS

The common animal fats used as food are lard, beef fat (suet), mutton fat, butter, and small quantities of the fat of the hen, duck, goose, etc. By the process of "rendering," the fat is separated from the connecting tissue, which settles to the lower part of the kettle as "scrap."

[1] Chem. Abs., Vol. 6, pp. 2550–2551.

LARD

There are several grades of hog fat, sold under the name of lard, as made at the large packing houses. The highest grade which is known as "Leaf Lard" or occasionally as Neutral Lard No. 1, is made from the fat surrounding the kidneys. This fat, which has been washed and chopped, is heated at as low a temperature as possible, in steam-jacketed kettles, as there is less charring of the residual matter and consequently the product is of a lighter color than when the fat is heated in an open kettle. The fat thus obtained is sometimes washed with water containing a little salt and sodium bicarbonate.

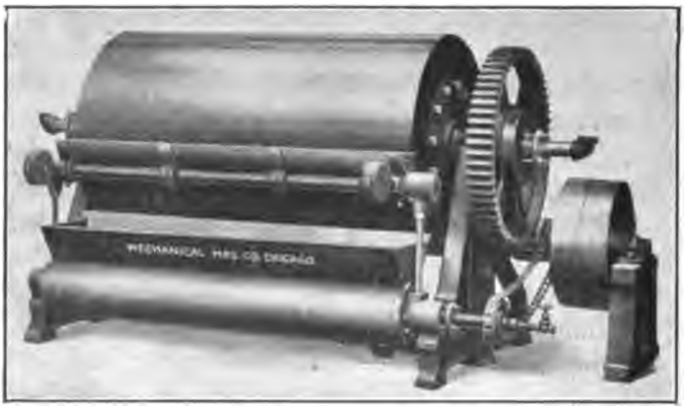

FIG. 46.—Lard Roll.

"Refined Lard" is a product that is sometimes made from "prime steam lard" by heating it in a tank to 170° F. and at the same time blowing air through it to remove the moisture. It is then agitated at a temperature of 160° F. with Fuller's Earth, to bleach it, and finally filtered through a mechanical filter press. In order to "bring it to grain," it is cooled rapidly, either by agitating in a tank surrounded by cold water, or by running the lard on to a large revolving roll which is filled with ice-cold brine. (Fig. 46.)

The lard is scraped from the roll as the drum revolves, and is then ready to be packed for market.

"Steam rendered Lard," or "prime steam lard," is the lowest grade of the packing house. It is extracted from the "stock," under a pressure of about 50 pounds, by admitting steam to the tank which contains the hog fat from various parts of the animal. When the material is completely "rendered," the fat is run off from the scraps, and quickly cooled. "Kettle rendered" lard should be of a high quality, and the process should be similar to domestic practice in which the kettle is heated externally, and the temperature used is not excessive.

Lard is frequently stiffened by the addition of lard stearin, but the use of beef stearin for this purpose would be considered an adulteration. Lards thus stiffened "stand up" better in a warm climate, and are therefore more satisfactory.

Lard oil is obtained by subjecting the lard contained in woolen bags, to hydraulic pressure. The oil which is expressed is chiefly olein, and is of a pale yellow color and has a peculiar bland taste. It was formerly used as a burning oil for lamps, and at the present time finds some use as an edible oil and for lubricating purposes. In France it has been used as an adulterant for olive oil. The stearine which remains in the press is known as "lard stearine," and is used in making "Compound Lard," and for similar purposes.

Lard Substitutes

On account of the cost of pure lard, a large number of substitutes have been proposed, and some have found a very extensive use. As long as they are sold under their true names as substitutes, if they are carefully made of clean, wholesome material, there can be no objection to their use. Vegetable fats and oils are by many believed to be more wholesome than lard and they contend that compound lards are really better for general use from a hygienic standpoint. Compound lard, which is sold under various names as "Cottolene," "Cottosuet" and "Snowdrift," is a mixture of such materials as cotton-seed oil, lard stearine, beef stearine and sometimes lard. The cotton-seed oil used is purified and bleached by filtration through Fuller's earth before being mixed with the other ingredients. A variety of grades of different melting point are put upon the market for use in different climate and at different seasons of the year.

Uses of Lard

Lard like other fats is readily assimilated, and quite completely digested in the intestines. Its use as "shortening" diminishes the adhesiveness of the flour, and prevents the pastry from being tough. When used for "deep frying," if the temperature is too high, *i.e.*, from 480° to 570° F., some of the fat is liable to be decomposed and the glycerol is converted into acrolein, a substance which has a characteristic acrid odor, and which excites to tears, thus $C_3H_5(OH)_3 - 2H_2O = C_3H_4O$ (acrolein). The products of this decomposition, when compound lard is used in the place of lard, are more noticeable and can be recognized by their peculiar odor.

Adulterations of Lard

The common adulterants of lard are other fats and oils both vegetable and animal, which cheapen the product. Cotton-seed stearine, peanut oil, sesemé-oil, corn oil, cocoanut oil and cotton-seed oil are commonly used. There is no objection to any of these from hygienic reasons. Water has sometimes also been mixed with the lard, but this form of adulteration is easily detected and is not common. The more water a lard contains the more it "sputters" when heated to a high temperature.

BEEF FAT (SUET): MUTTON FAT

Beef and mutton fat, as such, are not often put upon the market as food products. They are of course of importance as constituents of the meats. Suet is sometimes used in the place of lard, or mixed with lard in the cooking of food, although it is not as satisfactory for general domestic use. These fats are of great importance in the industries of soap and candle making, for which the lower grades may be used.

GLYCERINE

A by-product in the manufacture of soap is glycerine (glycerol) ($C_3H_5(OH)_3$). Although not in itself regarded as a food product, yet as a constituent of fats it is of interest. In the process of making soap, the glycerine remains mixed with the excess of alkali, in the liquor from which the soap has been separated. After as much as possible of the common salt has been separated from spent lye by evaporation, the "mother liquor" is treated with various chemicals, especially a sulphate of iron[1] which causes a precipitate of many impurities which are then filtered off. The clear liquid is then evaporated in a vacuum pan, until the crude glycerine reaches such a density that it contains about 80 per cent. of glycerine. It is then distilled under a very high vacuum with superheated steam, and under these conditions passes over with the steam and is afterward concentrated, until it reaches a specific gravity of 1.262. This is filtered and sold as dynamite glycerine. A purer product is obtained by bleaching, filtering and redistilling the crude glycerine. The properties and uses of this sweet, bland, unctuous liquid are too well known to require description. (For Butter Fat see p. 406.)

VEGETABLE OILS

Vegetable oils are most frequently found in greatest abundance in seeds of plants, and are extracted by pressing the ground or crushed seed, the mass being sometimes heated to obtain the maximum yield of oil, or the seeds may be extracted by the use of some solvent such as gasoline.

[1] Outlines of Industrial Chemistry, Thorp, p. 348.

Most of the "cold-drawn" vegetable oils from seeds and fruits are suitable for use as edible oils, or for the preservation of foodstuffs. It is especially important in the preparation of edible oils that they be free from fatty acids. To bring about this result alkalies and alkaline earths are used in the process of manufacture. These oils are more satisfactory if they do not congeal at temperatures near the freezing point. Olive oil usually fills this demand, but some other oils like cotton-seed oil and peanut oil must first be "demargarined" before they are satisfactory. To accomplish this the oil may be stored in the winter in large tanks where the stearine settles or crystallizes out, and from which the clear, supernatant oil is drawn off, or the oil may be artificially cooled to so low a temperature that the "stearine" may be removed by filtering, pressing or passing through a centrifugal.

Use of Vegetable Oils

For the production of heat and energy in the body, the vegetable fats are very valuable. As compared with sugar, fats are two and one-fourth times as effective, and are, therefore, to be regarded as a highly concentrated form of nourishment. The oils and fats, if well emulsified (that is, broken up into very fine particles), may be quite largely digested by the gastric juice. Otherwise, they are decomposed in the intestines into fatty acids and glycerol (glycerine) which recombine in passing through the intestinal wall.[1] The fat thus absorbed is taken up by the lymph vessels, and is poured with the lymph into the blood.

Since vegetable oils are readily assimilated and digested they may, in most cases, be taken into the system in relatively large quantities, and have been found to be extremely useful in the treatment of some diseases.

Vegetable oils, as well as animal fats like lard, are utilized in the preparation of pastry, and for frying foods. The products of decomposition of the fat (see p. 312) may produce indigestion, if

[1] Chemistry of Food and Nutrition, Sherman, p. 94.

taken in any considerable quantity. Another reason why substances cooked in oil or fat are not so easily digested as those cooked with steam or water is that when the material becomes saturated with fat it is so protected that the digestive juices cannot readily come in contact with the carbohydrates and proteins of the food. If food products are to be cooked in deep fat—the process used in cooking doughnuts—it is important that the temperature be sufficiently high so that very little fat is absorbed.

A. H. Church[1] gives the following list of oil-bearing vegetable products with the percentage of oil present in each:

	Per cent.
Palm nut (pulp)	72
Brazil nut (seeds)	67
Almond (kernels)	54
Ground nut (peanut)	52
Sesamé (seeds)	51
Poppy (seeds)	45
Olive (pulp)	39
Olive (kernels)	44
Cacao (seeds)	44
Cocoanut (meats)	36
Hemp (seeds)	32
Walnut	32
Cotton (seeds)	24
Sunflower (seeds)	22
Oatmeal	10
Corn (maize)	5

To these may be added the following which are of less commercial importance: Rape or kolza seed, mustard seed, tomato seed, raisin or grape seed, apple seed, apricot and peach kernel and the soy bean, all of which contain enough oil to be of some commercial importance.

Palm oil is obtained by the cold pressing of the nuts. In many tropical countries, especially in Africa and the Philippines, there are numerous varieties of palms, from the soft part of the fruit of which, palm oil is obtained. It is semi-solid at ordinary

[1] Food, p. 36.

temperatures, has an agreeable taste and odor, and in the countries where it is produced is extensively used for food purposes. The chief constituent of palm oil is palmitin. As this oil is made by the natives, by the crudest methods, it often contains many impurities. These are removed and the oil is bleached by various processes, before it is put upon the market for food purposes.

There is also a **palm nut oil** on the market made from the kernels after the removal of the pulp. This is used in the manufacture of butterine and butter substitutes, and is sold as vegetable butter under various proprietary names.

Almond oil, which is especially used for pharmaceutical purposes, is obtained from either the bitter or the sweet almond. The former contains a greater percentage of oil and is more generally used for this purpose. Bitter almonds are grown most abundantly in the countries around the Mediterranean Sea, in Persia and the Canary Islands. The glycerids[1] in almond oil consist chiefly of olein, with smaller quantities belonging to a less saturated series. Almond oil is sometimes adulterated with cheaper oils, especially apricot-kernel oil and peach-kernel oil.

Peanut or arachis oil is prepared by the cold hydraulic pressing of peanuts, (See p. 202). The nuts are grown in the warm climate of South America, South Africa, China, Japan, India and southern United States. The more tropical the climate the richer the nuts in oil.[2] The best quality of oil is the first pressing, called "cold-drawn oil," while subsequent cold pressings, or pressings with heat, yield products of lower grade. From 28 to 34 per cent. of oil can be obtained from peanuts, and the residue that is left (peanut cake) is rich in proteins and starch and valuable as a stock food.

This oil may be used as a salad oil either alone or mixed with sesamé oil. It has unfortunately been very much used as an adulterant of olive oil, and is itself often adulterated with cotton-seed, poppy-seed and other less expensive oils. Peanut oil on

[1] Chem. Tech. and Anal. of Oils, Fats and Waxes, Lewkowitsch, p. 589.
[2] Die Futtermittel des Handels, 1906, p. 34.

account of its taste, odor, and fluidity is valuable as a salad oil, and as such should be sold under its true name. It is also an excellent substitute for lard as "shortening," or in other culinary processes. It is superior to most oils for "deep frying," as it does not burn as readily as olive oil, and can thus be heated to a higher temperature. Much of the peanut oil of commerce comes from France where it is made from the African-grown peanut which often contains 50 per cent. of oil.

Sesame oil, also called oil of benné, is obtained by pressing the seeds of the *Sesamum orientale L.* The plant is a native of southern Asia and is grown for the seed in India, China, Japan, the Levant, and West Africa; but the commercial preparation of the oil is mostly carried on in the south of France.[1] The best grades of sesamé oil are a golden yellow in color, free from any disagreeable odor or taste, and may be used in the place of olive oil as a salad oil, or in making oleomargarine. The cheaper grades are utilized for making soap and for lighting purposes.

Poppy-seed oil may be made from the black or white poppy seeds. These are grown for oil and for opium in Europe, Turkey, Persia, India and China and Germany. The better grades of oil are of a light color, and have an agreeable taste, while lower grades are darker in color, and possessed of a strong taste. This oil is much used abroad as a salad oil. It is frequently adulterated with cheaper oils,[2] such as sesamé and hazel nut oil.

Olive oil (sweet oil) is obtained from the pulp, and sometimes from the kernels of the olive. (See p. 284.) Olives contain from 40 to 60 per cent. of oil, and to extract this the olives[3] are carefully selected, sometimes dried, and crushed (with or without the stones), and from the pulp, by gentle pressure at ordinary temperatures, the "virgin oil," which is the name applied to the best quality, is obtained. The pomace is taken from the press reground, mixed with water and again pressed for a second grade of oil. The mass may be heated before the next pressing or the pomace may be

[1] Foods and Their Adulteration, Wiley, p. 408.
[2] Food Inspection and Analysis, Leach, p. 427.
[3] U. S. Dept. Agri., Bu. Chem. Bull. No. 77.

extracted with carbon bisulfide or petroleum ether. When these solvents are distilled off, the oil remaining is used in the manufacture of "castile soap," and for making lubricating oils. After the high grades of oil are extracted, they are still further purified by being run into tanks and washed with water, then allowed to stand until the pulp and gummy material settles out, then the oil is carefully drawn from the top. Olive oil may also be filtered to improve its appearance, but this is to be discouraged, as the

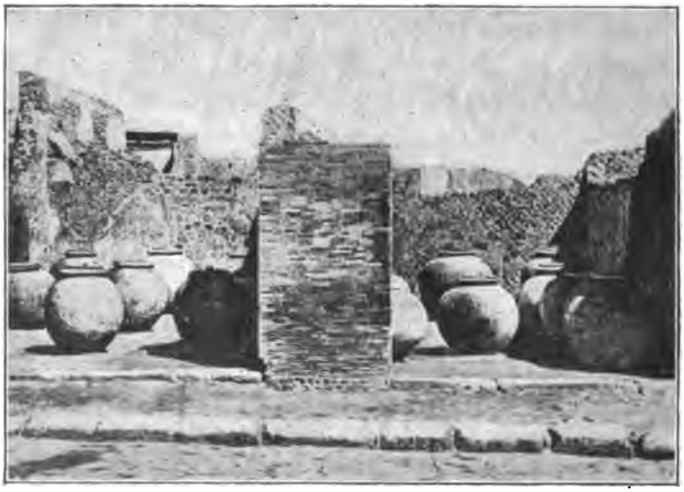

FIG. 47.—Olive oil jars found in Pompei.

flavor of the oil is said to be less agreeable after the process. (See p. 321.)

Adulteration of Olive Oil

In regard to adulterations that most common all over the world has been the adulteration of the olive oil with some cheaper substitute. The oils especially used for this purpose are cottonseed oil and peanut oil. Rape-seed oil and poppy-seed oil are common adulterants in Europe, but not so frequently used in the United States. These adulterations are readily detected by chemical analysis, and the pure food laws of most countries and states are at the present time sufficiently well enforced so that the amount of fraudulent olive oil on the market is not large. There is no objection, from a hygienic standpoint, to the use of cottonseed oil or peanut oil, for making salads and for other culinary purposes, but the package should be plainly marked so that the customer need not pay a high price for a cheaper article. Mustard oil, made from a seed grown especially in Switzerland and Italy, is commonly used in those countries as a substitute for olive oil.

The amount of edible olive oil imported into the United States in 1913 was 5,840,357 gallons.

Cacao fat (butter) is one of the few vegetable fats that is solid at ordinary temperatures. It is prepared by pressure of the roasted and crushed cacao beans or nibs. (See p. 478.) A little potassium or sodium carbonate is mixed with the mass before pressure to neutralize any free fatty acid that may be present. Cacao butter has a pleasant odor and a flavor suggestive of chocolate, and is extensively used in pharmacy, in the manufacture of chocolate, and in the preparation of perfumes. On account of its high price, it is frequently adulterated with cocoanut oil, palm nut oil, bees wax, paraffin and even tallow. It is important to distinguish carefully between the cacao (Theobroma cacao L.) and the coconut (Cocos nucifera L.), a species of palm.

Coconuts, since they are abundant and cheap in the tropics, have long been used as a source of fat. The coconut palm grows on the low-lying coast lands of the West Indies, Panama, tropical Africa, India, the Malay Archipelago and the islands of the southern Pacific. (See p. 334.) There are several names for the oil, dependent on the country in which it is made.[1] Thus "cochin" oil comes from Malabar, "Ceylon" oil from the island of that name, "copra" oil is the term applied to the oil obtained from the sun-dried kernels. This is prepared by the natives by boiling the kernels with water and removing the fat by skimming.[2]

[1] Chem. Tech. of Oils, Fats and Waxes, Lewkowitsch, p. 745–752.
[2] Foods, Their origin, Composition and Manufacture, p. 359, Tibbles.

"Poonac" is the name of the oil cake after the extraction of the oil, and is a valuable cattle food. Most of the oil on the market is made from the copra, usually by pressing. Large quantities of dried copra are imported into this country and used here for expressing the oil.

Coconut oil is semi-solid at ordinary temperatures. It has an agreeable taste and odor, and keeps well, if free from fatty acids. It is commonly believed that the oil becomes readily rancid, but this is a mistake if the oil is good in the beginning. Coconut oil may be used in the preparation of food, by bakers and biscuit manufacturers and in making oleomargerine and candies, but its principal use in the United States is in soap and candle making. It is seldom adulterated on account of its cheapness. A pure neutral coconut oil is extensively used abroad for culinary purposes, under various proprietary names such as "Vegetable Butter," "Conut," "Vegetaline," "Coconut Butter," etc. Desiccated coconut with or without sugar is a common product on the market.

Cotton-seed oil is made from the seed of the cotton (gossypium herbaceum), and other species. It is grown in Egypt, India and in the United States in the South and as far north as the southern part of Virginia, Missouri and Oklohoma. The seed[1] is first passed through machines which remove the "linters," or short cotton fibers, which are afterward used in making cotton felt. The cleaned seeds are then transferred to a shelter where the hull is broken, and separated from the kernel in a winnowing machine. The kernels are crushed between rollers and then delivered to steam-jacketed kettles where they are cooked, with constant stirring. The mass is then passed to the "former," where the meats are shaped into cakes which are wrapped in hair cloth and removed to the press, where they are subjected by hydraulic power to a pressure of 3000 to 4000 pounds per square inch. (Fig. 48.) When the oil presses are working satisfactorily, about

[1] U. S. Dept., Agri., Farmers' Bull. No. 36.

45 gallons of oil can be obtained from a ton of seed. The cakes taken from the press are nearly as solid as a board, and when dry they are broken up and ground to a fine meal which is put upon the market as stock food.

The dark yellow oil which runs from the press must be purified. It is first allowed to stand until some of the impurities settle out, when the clear oil is drawn off and agitated with from 10 to 15 per cent. of caustic soda solution at 100 to 110° F. for forty-five minutes. The residue which settles out after this treatment is drawn off and used for soap stock.

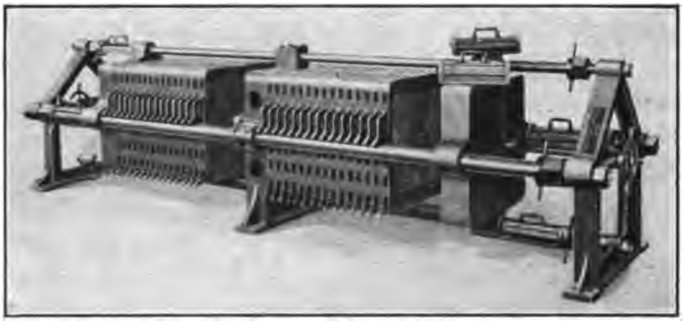

FIG. 48.—Filter press as used in the oleo, vegetable oil, sugar and other industries (Mechanical Mfg. Co., Chicago.)

The yellow oil thus prepared is often further purified by again heating and settling, by filtration, or especially for winter use, by chilling until some of the stearine crystallizes out. This is the "cotton-seed stearine" of commerce, and is used in the manufacture of compound butter and lard substitute, and also in making candles. A still lighter colored oil may be made by filtering through Fuller's earth.

The summer yellow oil is of a golden color, and the winter yellow is more or less demargarined so that it shall not become cloudy in winter from the separation of the stearine.

As a food the oil has rapidly grown in favor as the quality of the oil upon the market has been improved. Within the last few years an oil that is practically tasteless and odorless can be purchased. It is as wholesome as an animal fat, and is admirably adapted to many culinary uses.

The growth of the cotton-seed oil industry is one of the most remarkable instances of the utilization of by-products. For many years the plant was grown exclusively for the fiber, and the seeds were thrown away or burned. It is estimated that the products now obtained from cotton seed alone, in a single year in the United States, are worth over $30,000,000.

Sunflower seeds, although containing considerable oil, have not been utilized practically in the United States as a source of oil.[1] In some European countries sunflower seeds are eaten as an ordinary food. The plant is extensively cultivated in S. Russia, Hungary, Italy, India and China for food purposes. The oil is palatable and makes, without refining, an excellent salad dressing. The finest grade is made by the cold pressure of the hulled seeds, and a reddish oil is expressed hot from the roasted seeds. The residual oil cakes are as valuable as cotton-seed oil cake for feeding purposes.

Corn oil (maize oil), which is made from the germs of the grains which can be separated in the process of milling, is coming into more general use in the manufacture of food products. The germ contains over 20 per cent. of oil, the odor and taste of which are agreeable and are due to the presence of a volatile oil.[2] Most of the corn oil of commerce is obtained as a by-product from starch and glucose factories. This oil contains, besides palmitic, stearic and arachidic acids, an unsaponifiable substance mostly lecithin. It is used as an edible oil, frequently mixed with other vegetable oils, also in the manufacture of oleomargarine, lard substitutes, etc. The lower grades are used for making soft soap and as burning oil.

Rape, Colza or **Rübeen** oil made from rape seed is an excellent oil for culinary purposes. That made by cold pressing of the

[1] U. S. Dept. Agri., Div. Chem., Bull. . No. 60

[2] Jour. Am. Chem. Soc., Vol. 23, p. 1.

powdered seeds is of the best quality. The plant is grown nearly all over Europe and also in India and China. When fresh the oil has an agreeable taste and odor, but on long standing a disagreeable taste and odor are developed. The oil frequently comes on to the market greatly adulterated with cheaper oils such as cotton-seed, hemp seed and poppy seed.

The seed of the **white or the black Mustard** may be used for the preparation of an excellent bland oil that is sometimes used in the place of an animal fat for culinary purposes. This fixed oil is extracted by pressure as a by-product in the preparation of mustard as a condiment, especially from the black mustard. After the expression of a part of the oil the press cake is ground in steel mortars and bottled to make the ground mustard of commerce. The oil is also suitable for burning and for soap making.

Tomato seeds have been recently employed, especially in Italy, as the source of an edible oil.

Apricot-kernel oil and **peach-kernel oil** are both edible oils, and important articles of commerce. The so-called "almond oil French" is practically apricot-kernel oil, or a mixture of this with peach-kernel oil.[1]

The Soy bean (see p. 195), which grows in China and Japan, has been more recently cultivated in southern Europe and in the United States It contains 18 to 19 per cent. of oil, which is of such a good quality that it will no doubt come into more general use all over the world.[2]

To the list above discussed may be added a large number of foreign nuts and fruits that yield oils and fats. Many of these are edible and are in common use by the natives of the respective countries where they grow. The methods used for extraction of the oils are so crude that the product is frequently of a much lower quality than if modern methods were used. Some of these oils are as follows:[3] Cohune oil from the Cohune palm of Central

[1] Chem. Tech. Anal. of Oils, Fats and Waxes, Lewkowitsch, p. 583.
[2] U. S. Dept. Agri., Farm. Bull. No. 372.
[3] Fatty Foods; Bolton and Revis.

made
grown
fat,
oil
made

CHAPTER XIII

NUTS, AND NUT PRODUCTS

Although in many countries some varieties of nuts have been used as food for a long period, in the United States, until comparatively recent years, the tendency has been to regard them as a luxury, or a confection, rather than as a food. Many of the nuts in common use, if compared in price with the more expensive forms of breakfast foods, are not an expensive food. While imported nuts were an expensive luxury, the native nuts, such as hickory nuts, walnuts, butternuts, chestnuts, hazel nuts and pecans, were formerly to be had by any one for the gathering; and in most parts of the United States this is still the case.

Structure

We recognize a nut as usually consisting of a somewhat oily meat or kernel, protected by a hard covering, the shell, and designed by nature as the seed for the propagation of the plant. The nut-bearing trees belong to various botanical families.[1] Some are deciduous trees, as the chestnut, walnut, and hazelnut; others are pines or tropical palms; while others are even legumes. Nuts possess the advantage over many other foods, that the meat is well protected, and so they bear transportation, rough handling and low temperature. They deteriorate chiefly by becoming wormy, rancid or musty, but if kept cold they do not spoil rapidly.

Composition

Considering the composition of nuts, we find that the most abundant constituents are fat and protein, although in some there

[1] Nuts and Their Use as Food, U. S. Dept. Agric., Farmers' Bull. No. 332.

is an abundance of starch. As nuts usually contain but little water, they afford a very concentrated form of nutriment. Those having a high fat content—upward of 60 per cent.—are the pecan, brazil nut, butternut, filbert, candle nut, hickory nut, pine nut, and walnut. Those especially rich in protein—over 20 per cent.—are the pignolia, a pine nut from Spain, peanut, butternut, almond, beechnut, candle nut, paradise nut, and pistachio. Those which are prized for their starch content—over 40 per cent.—are the acorn, chestnut, water chestnut, chufa (earth almond), and the ginkgo nut.

Digestibility

Recently the digestibility of nuts has been quite extensively studied at various Agricultural Experiment Stations, notably that of California. If the true composition of nuts was better known and they were used understandingly, they would not have the reputation for indigestibility that they have obtained. As has been shown above, compared with ordinary foods, like meats which often contain 70 per cent. of water, they are a very concentrated form of nourishment, and so should not be eaten in large quantities, especially when the stomach has already been filled to repletion. We should look upon nuts as food, just as we are beginning to regard sugar as food, and use them as such in proper quantities and at the right time, and they will prove extremely valuable and occasion no discomfort. The experiments that have been made[1] with fruit and nut diets seem to indicate that nut protein is about as easily, although possibly not as completely digested, as the proteins of bread and milk.

It is true that a diet composed exclusively of fruits and nuts contains sufficient nutrients in the right proportion to support life, but experiments have shown that the protein from a mixed diet is more economically utilized than that from a single food, or a very limited variety. On this account those who use nuts in the

[1] Loc. cit.

place of meat should not depend upon nuts alone as the food supply, but should use at the same time more bulky foods, with a low content of protein and fat. Comparing nuts for their fuel value,[1] they may be arranged in the following order: roasted peanuts, unroasted peanuts, chufa nuts, almonds, pecans, English walnuts, filberts, hickory nuts and walnuts. The peanut on account of its high fuel value, and its cheapness, is one of the most useful nuts on the market. The fuel value per pound of nuts as purchased varies from peanuts 1775, to butternuts 385.

Cooking

Some nuts are improved in flavor and also rendered more digestible by cooking. In the United States the native chestnut, although often eaten raw, is much improved in flavor and digestibility by roasting or boiling. It is the cooked chestnut that finds favor as an important food material in Europe, especially in Italy and France. Chestnuts are often used for stuffing turkeys, and the combination of the starchy chestnut with the meat, which is rich in protein and fat, makes a well balanced ration.

Nut Preparations

Nut butters, especially peanut butter, on account of their agreeable taste and nutritive qualities, are coming into more general use as a substitute for ordinary butter. "Pastes" are also made from nuts with the addition of sugar.

In the preparation of nuts for market, unshelled nuts like the pecan are often polished by rotating in revolving drums, and a little pigment or dye is sometimes added to improve the appearance, and make the nuts more salable. Nuts are also bleached by the use of sal soda, chloride of lime and water. These processes which in no way increase the food value of the product, are entirely unnecessary and add to the cost.

The term "blanching" is applied to the method used in re-

[1] Proc. Ia. Acad. Sci. Vol. 10, p. 111. Compare, Rep. Me. Exp. Sta., 1899, p. 87.

moving the skins from the kernels, as of almonds, by immersing them in boiling hot water and then rubbing off the thin coat thus loosened.

Shelled nuts are very common on the market at present. As the meats are sometimes picked from the shells under most unsanitary conditions, and as dust and dirt are very liable to settle on them, they should be washed, preferably with hot water, before being used.

Another use for nuts is in the making of coffee substitutes. Peanuts and acorns are generally used for this purpose; but only a small proportion of the nuts is soluble in hot water, so these beverages are not very nutritious.

NUTS

The following nuts are in common use in various parts of the world:

Acorn; the fruit of various species of oak (Quercus).

Almond; the fruit of the (Amygdalus communis) var. Dulcis and Amara.

Beech nut; the fruit of the (Fagus sylvestris) or (F. Americana).

Brazil nut; growing on the (Bertholletia excelsa).

Cashew nut; from the (Anacardium occidentale).

Chestnut; the fruit of the (Castanea dentata).

Canarium nut, Pili nut, or Javanese almond (Canarium indicum) (C. ovatum).

Chinkapin; growing on the (Castanea pumila).

Coconut; the fruit of the (Cocos nucifera).

Ginkgo nut; the fruit of the (Ginkgo biloba).

Hazelnut; the fruit of the (Corylus avellana, C. tubulosa, and C. grandis).

Hickory nut; the fruit of the (Hicoria avata).

Paradise nut; grown on the (Lecythis usitata).

Peanut; a leguminous pod bearing the seed of the (Arachis hypogœa).

Pecan nut; the fruit of the (Hicoria pecan).

Pine nut; the fruit of the pine (Pinus edulis, P. monophylla).

Pistachio nut; the fruit of the (Pistacia vera).

Walnut; the fruit of the (Juglans nigra).

Walnut (white); the fruit of the (Juglans regia).

Walnut (butternut); the fruit of the (Juglans cinerea).

Walnut (Japanese); the fruit of the (Juglans sieboldiana).

Litchi nut; not a true nut but the fruit of the (Nephelium litchi).

Acorns were at one time extensively used in the United States for fattening swine, but they are becoming less abundant as the country is more thickly settled. They contain 45 per cent. of starch and sugar and 37 per cent. of fat.

Acorn flour,[1] especially among the North American Indians, has been used as food. In the process of manufacturing, the nuts are leached to remove the tannin and bitter principles, and then after beating them into a meal, this is made into a porridge or mush.

In Turkey where acorns are used for food they are buried in the earth in order to remove the bitter taste. They are afterward washed, sweated, dried and ground to a powder with sugar and spices. This is called "palamonte." Of this a beverage known as "raccahout" is made.[2]

The **sweet almond** is the pit or seed of an inedible fruit which grows in sub-tropical countries, especially in California, Morocco, France, Italy, Spain and Portugal. The tree with its blossom and immature fruit much resembles the peach.

Sweet almonds are often named from the country whence they come, as Valencia, Sicily, Italy, or Barbary almonds. There are several varieties of almonds, some called paper shells, with the shell so thin that it can be readily crushed with the hands, and others so hard that they cannot be opened in this way. On account of the tariff in the U. S. almonds are usually imported with the shells removed, as this is more profitable. American-grown

[1] Nuts and Their Use as Food, U. S. Dept. Agri., Farmers' Bull. No. 332.

[2] Tibbles, p. 684.

almonds, especially the soft-shell variety, are usually marketed in the shells.[1]

Jordan almonds, a hard shelled variety, with a thinner integument and more delicate flavor than other varieties, are imported from Malaga in southeastern Spain, and command the highest price in the market. (Fig. 49.) There is some doubt as to the origin

FIG. 49.—Jordan almonds. (By permission U. S. Dept. Agric.)

of the name "Jordan," as some believe that this variety was first introduced from the vicinity of the river Jordan, while others contend that the word is simply a corruption of the French word "jardin," garden.[2]

Besides being used as nuts, almonds are ground into a flour and

[1] U. S. Dept. Agri., Bu. Chem. Bull. No. 160.
[2] U. S. Dept. Agri., Bu. Plant Ind. Bull. No. 26.

used for making paste, bread, and "*marzipan.*" Some varieties of nuts are eaten before they are fully matured. In many parts of Europe and in California, green almonds are found in the market and are considered quite a delicacy. The kernel is easily separated from the immature shell and pulp by the use of a knife.

The **bitter almond,** while not very poisonous when fresh, has a disagreeable taste, and this, in addition to the fact that one of the products of the decomposition is hydrocyanic acid (HCN), makes it undesirable as a food. They are grown in large quantities in southern Europe, however, and are the chief source of "oil of bitter almonds." Much of the prussic acid of bitter almonds is dissipated in the process of cooking, and small quantities of these almonds may be used as a flavor. On account of the fact that almonds do not contain starch, only sugar, gum, fibro-cellulose, and fat, they are of value in the diet of diabetic patients.

The pit of the bitter almond, like that of the peach, apricot, and other members of the *prunus* family, contains a glucoside called amygdalin ($C_{20}H_{27}NO_{11}$), which, when the nuts are ground with water, produces with the emulsin, an enzyme also present, glucose ($C_6H_{12}O_6$), 85 per cent. of benzaldehyde (C_7H_6O) and from 2 to 4 per cent. of hydrocyanic acid (HCN).[1] Either bitter or sweet almonds may be used for the production of the "expressed" oil of almonds, and the resulting press-cake from the sweet almonds is an excellent stock food.

Beech nuts are triangular in shape, and very abundant in some localities especially in the north. The nuts are small and have an agreeable taste, but there is so little meat in the shell that the trouble of getting it out is rather more than it is worth. They are a favorite food of hogs, and a winter food for squirrels and birds. In Siberia the oil of beech nuts is used as a substitute for butter.

The **Brazil nut,** known also as the cream nut, contains in the ebdile portion 66 per cent. of fat, and 17 per cent. of protein. This is the fruit of a large South American tree which will not

[1] U. S. Pharmacopœia, p. 306.

withstand the climate of the United States. The nuts are borne in a large dry shell which contains about twenty nuts closely packed together. They are quite liable to become rancid when kept too long.

The **Sapucaia or Paradise** nut, which is borne by another tree of this same family, is about as large as the Brazil nut, and has a rough shell, but is usually not so much curved as the Brazil nut. It is of finer quality, and more delicate texture, but has not yet become common on the market in the United States. It contains but little starch or sugar.

The **Canarium nut** or **Javanese almond,** known also as the *Pili nut*, which is highly appreciated in the Orient, has recently been introduced into the United States from the Philippines, and by the immigrants from Asia and the East Indies. The tree is native in the East Indies and the Philippines. The nuts are spindle shaped, with a triangular cross section. The shell is very thick and hard and incloses a white oily kernel, which is comparatively tasteless. The kernel is eaten in the Moluccas, both raw and roasted. These nuts are often used to mix with other nuts of a higher price in making up lots of mixed nuts. An oil is expressed from the nuts which the natives use for table purposes and in lamps.

The **cashew or maranon** fruit and nut, a native of tropical America, grows readily in the East and West Indies, South America and the Philippines. It is a small oddly shaped yellow and red fruit, 2 or 3 inches long, of pyramidal form, and bears at its distal end the nut or seed, which is small and kidney shaped. (Fig. 50). This arrangement of the seed outside the pulp of the fruit is remarkable. The seed is inclosed in a grayish-brown cellular coat that contains an essential oil which has a blistering effect upon the skin, due to the presence of cardol and anacardic acid.[1] The ripe fruit and nut are eaten in Brazil and the fermented juice is used to make a wine which by distillation yields a spirit much like rum. A similar intoxicating drink called

[1] Phil. Jour. of Science.

"kaju" is made by the natives of eastern tropical Africa. The seed is said to be poisonous, owing to the presence of hydrocyanic acid, but after it is roasted an agreeable flavor similar to roasted chestnuts is produced. The fruit is generally used as a preserve.[1] From the nut a nutritious oil similar to almond oil is expressed.

FIG. 50.—The cashew fruit and nut. (By permission U. S. Dept. Agric.)

The **chestnut tree** grows readily in the eastern part of the United States, especially toward the north. It does not have so large a range as some of the other nut-bearing trees. For many years the finest chestnut trees have been cut for lumber in the American forest, so that few of the original trees now remain. A serious blight has recently appeared in New England which threatens to exterminate this beautiful tree. This tree grows wild over a large area in Europe from the Caspian Sea to Portugal, and there is a wild variety in Japan. Eight of the well-known varieties were mentioned in the time of Pliny. The chestnut

[1] Foods and Their Adulteration, Wiley, p. 348.

is also extensively grown in France and southern Europe. Here a flour is made from the dried nuts, which is used in the preparation of cakes. In Italy a porridge called "polenta" is made from the ground chestnuts. In the Appenines, a cake of chestnut flour called "necci," baked on hot stones, is a staple food product. The itinerant chestnut roasters of the Italian cities find plenty of customers for this food. The nut may be eaten raw, roasted or boiled. They are often used with meat or game as "stuffing."

The composition—starch and sugar 43.1 per cent., fat 6.3 per cent., protein 6.5 per cent.—shows the chestnut to be one of the most valuable starchy foods, so that it may well replace Indian corn (maize) in the dietary. Single kerneled chestnuts have been grafted on original stock in some localities, producing a larger variety. The *chinkapin* is a smaller nut, which grows on a low tree or shrub, closely related to the chestnut, in the southern and eastern part of the United States.

The **horse chestnut** (Esculus hippocastaneum) is common throughout the temperate regions of Asia, Europe and America. Although it contains an abundance of starch (68.25 per cent.), it is only fit for use as food for the lower animals, because of its containing tannin and sapotoxin, which cannot be readily removed. The North American Indians are said to have sometimes used the horse chestnut as food.

The **coconut** is the staple food of many of the natives of the islands of the Pacific. (Fig. 51.) The meat of the coconut encloses the "milk" which is gradually absorbed as the nut reaches maturity. (See p. 319.) The liquid milk is used in the same way as cow's milk. The white meat which is scraped and eaten with rice in "curries," is a very important article of commerce, when grated and dried, and keeps fairly well. It contains 5 per cent. of protein, 60 per cent. of fat and 27 per cent. carbohydrates. Shredded coconut dried with sugar is much used in confectionery and pastry. The use of these nuts in candy-making has already been discussed (p. 127).

The **ginkgo nut** is the fruit of a very ornamental tree of the

Yew family that may be easily grown in the United States. This is a favorite food product with the Chinese, but rarely used here. As the nut, which resembles a plum stone, is surrounded by an acrid pulp, this must be removed before using. The nut is usually roasted before it is eaten. The trees are from thirty to forty years old before fruiting, so few nuts have been borne in the United States.[1] There are several other Chinese fruits or nuts of this kind which have found their way into the markets of the United

FIG. 51.—A coconut grove. (By permission Central Scientific Co.)

States with the coming of the Chinese immigrants. Among these are[2] the "horn chestnut" and the "water chestnut."

In the United States the native hazel bushes produce a considerable quantity of **hazel nuts**, but a larger variety of the same species, known as the filbert, is imported from Spain and from Trebizond on the Black Sea. Another variety, known as the **"cob nut,"** which is broader and shorter and not of so fine quality as the filbert, is grown in Kent and Sussex, England. The Barce-

[1] Our Native Trees, H. L. Keeler, p. 490.
[2] U. S. Dept. Agri., Farmers' Bull. No. 332.

lona nut is a variety imported from Spain. Dried hazel nut meats contain 65 per cent. of oil, and this when expressed is known commercially in England as "nut oil." It is stated that the name "filbert" is a corruption of "full beard," and should be applied only to those varieties in which the husk is fringed and extends beyond the kernel, while other kinds should be called hazel nuts.

The **hickory nut** is one of the finest wild nuts of the United States. The variety known as "shell-bark" or "shagbark" is the best, while the inferior varieties known as "pig" nut and "hog" nut are not often used as human food. Recent investigations by the author[1] show that an excellent quality of oil that may be used for salads, may be expressed from the swamp hickory nuts. The hickory nut contains 15 per cent. of protein and 67 per cent. of oil, and on account of this high oil content is liable to become rancid if kept longer than over one winter.

The **peanut,** which is not a true nut, is discussed on page 202.

The **pecan** grows readily in the southern United States, notably Texas, Louisiana, Alabama, Mississippi, Georgia and Florida, and the tree is found growing wild over a large area. (Fig. 52.) It is of interest to note that with the introduction of new varieties, and more intensive cultivation, the area of pecan production is gradually moving northward.[2] As some choice varieties of pecans have originated in southern Indiana, northern Kentucky and lower Virginia, there is a hope that the tree may be successfully grown in these localities. Native trees are found in the Mississippi bottom lands from Davenport, Iowa, and Terra Haute, Indiana, toward the south and west.[3]

This nut is highly valued and commands a good price. In the nut-cracking factories located in the pecan-growing districts the meats are picked out, and sorted into whole and broken halves, and shipped to the northern market, where they sell at about 80 cents per pound. With careful cultivation the pecan trees begin to bear within three or four years after they are set

[1] J. I. and E Chem., Vol. V, No. 9.
[2] Bull. N. C. Dept. Agri., Vol. 32, No. 9.
[3] U. S. Dept. Agri., Bu. Plant In., Bull. 251.

out. The nuts contain 70 per cent. of fat, which is more than is contained in any other vegetable substance, and they are also fairly rich in proteins. They are grown only in the United States, and when we consider the immense quantities of foreign nuts of various kinds that are imported to supply the demand, there seems little danger that the growing of such an excellent nut as the pecan will be overdone.

FIG. 52.—The pecan branch and fruit. From "A Handbook of Trees of the Northern States and Canada. (By permission Romyn B. Hough.)

There are several pines that yield edible nuts, some of which are called "pinons." These grow mostly on the Pacific coast, and eastward to Colorado and New Mexico, and are extensively produced in southern Europe and India. In some sections they form quite a valuable addition to the food supply of the inhabitants. The American Indians formerly made great use of the pine nuts, and at the present day their descendants collect considerable quantities for the market. The pine cones in which the nuts are produced must be roasted so that the scales will fall apart sufficiently so that the seeds may be collected. The piñon is about as large as a bean, has a thin shell, and is usually of a brownish-red color. There is a variety on the Italian market known as the "pignolia," which is longer than the American varieties, and has a yellowish color. The meat of the pine nuts is of a rich delicate flavor usually without any suggestion of a resinous taste. They contain 14 per cent. of protein, 62 per cent. of fat and 17 per cent. of carbohydrates.

The **pistachio** or "green almond" grows on a tree that is a native of Syria. It has been cultivated in southern Europe and in the southern United States and California. The kernel of the Pistachio nut has a greenish color with a red pellicle. This nut is salted, while still in the shell, by putting into brine. The fruit, which is a drupe, is produced in clusters, and has a smooth stone which easily separates into two halves at maturity. The seed is blunt at one end and rather pointed at the other. To the radicle, which is located at the more acute end of the kernel, two large green cotyledons are attached. The thicker portions of the seed coat contain a dark red coloring matter, while the thinner portions are colorless and show the green color of the cotyledons beneath.[1] These nuts are highly prized both on account of their greenish color, and for their pleasant, rather resinous flavor. They are used to ornament and give flavor to ice cream and confectionery.

The **walnut** tree (black walnut) grows wild over a large portion of the eastern and central United States. On account of its value as lumber, great forests of these trees have been cut down. The nut is rich in oil, but does not remain sweet after the first winter.

English (white) walnuts are supposed to have come originally from Persia, but are now grown more extensively in south and southeastern France, and more recently in California. The trees are planted in rows, and cultivated with frequent fertilization

[1] U. S. Dept. Agri., Bu. Chem. Bull. No. 160.

with manure and commercial fertilizers. These orchards are very valuable as fruit producers. The outer pericarp or husk can usually be readily removed from the nut at the time of picking. They are sometimes prepared for the market by bleaching with chloride of lime, or other bleaching agents and polishing with soapstone is occasionally resorted to in order to improve their appearance. An excellent oil is extracted from the nuts.

The **butternut** is rich in fat and is closely related to the walnut, but by many it is considered as having a finer and richer flavor than the walnut. It is grown especially in the northern United States and in Canada. The nut contains water 4.4 per cent.; protein 28 per cent.; fat 61 per cent.; sugar, etc., 3.5 per cent. It is oval in shape, while the walnut is nearly spherical. The tree does not grow to as great size as the walnut, nor is the wood in as great demand for commercial purposes.

The **litchi,** a so-called Chinese nut, is not a true nut, but more properly a fruit protected by a nut shell. It is rich in starch and sugar (77 per cent). This nut is imported by the Chinese into the United States and is regarded by them as one of the best fruit products of China. They are often dried for winter use, and the Chinese use them in tea, in the place of sugar on account of their sub-acid flavor. They grow in China, India and the Malay Archipelago.

There are several nuts of less importance grown in various parts of the world. Among these may be mentioned the bread nut, the candle nut of the South Sea Islands, the ground nut of Europe, the kola nut of Africa, the quandang nut of Australia, the souari nut of British Guiana, the cream nut of South Africa, the Kingsland chestnut, the tabebuia of Zanzibar and the chufa nut or earth almond.

Nuts Imported

The almonds imported into the United States come mostly from Spain, Italy and France; the filberts from Italy, Asiatic

Turkey, and Spain; the peanuts that are imported, a total of 18,000,000 pounds, come from Japan, Spain, France, and the East Indies; walnuts from France, Italy, China, Austria-Hungary and Asiatic Turkey. The total value of all nuts imported, for the year ending June 30, 1915, was $16,865,344.[1]

[1] U. S. Bu. F. & Dom. Com., 2d Quar., 1915.

CHAPTER XIV

MEAT AND MEAT PRODUCTS

Flesh foods afford in general more concentrated nourishment than vegetable substances. This concentration which has been made in the animal body, generally by the use of vegetable substances, furnishes a food containing much protein and a small quantity of starch or sugar. The fat of the food which is necessary for the growth and nutrition of the body may come either from the vegetable or animal kingdom, and the balance of the ration can be built up by the use of a variety of foods containing starch and sugar. The legumes are the only vegetable foods that contain large amounts of nitrogenous material, and they are extremely useful in a mixed diet. (See p. 192.)

ANIMAL FOOD

Animal food may be classified in accordance with its origin into that from (1) mammalia, (2) birds, (3) fish, (4) other sea food, and (5) miscellaneous.

The common animals used for food include such domestic mammals as beef cattle, swine, sheep, goats, horses, camels and reindeer. Of less importance are wild mammals such as the deer, elk, moose, alpaca, llama, guanaco and antelope. Some carnivora, especially the badger, bear and raccoon, are often used for food, and among rodents the rabbit, hare, squirrel, marmot (wood chuck), beaver, hedgehog, porcupine and opossum. The mammalia living in salt water, namely, the porpoise, whale, narwale, walrus and seal, are in some countries utilized as food.

MEAT

The term meat generally includes not only the muscular tissue or lean meat, but all that is purchased, as meat including fat, tendons, skin and bones. As beef is a standard meat, it is convenient to study its properties as typical of the whole class. The amount of fat in meat varies within wide limits, and may be as low as 3 per cent. in beef to 90 per cent. in fat pork. Usually lean meat having from 8 to 12 per cent. of fat distributed through it is considered the most satisfactory. In an emaciated animal as low as 2 per cent. of fat is sometimes found in the lean tissue, but in a carcass which is in the condition for a good grade of beef as high as 8 per cent., and in an extremely fat carcass 22 per cent. of fat is found in the lean tissue.

Structure of Meat

Meat is made up of muscle fibers held together by connective tissue;[1] the latter is composed largely of lactin and collagen. Each fiber has a sheath or covering and within the fibers are contained the meat juices, which are solutions, in water, of proteins and non-protein nitrogenous extractives. (See p. 19.) The proteins of these juices consist chiefly of the globulin ***myosin***, muscle albumin and hæmoglobin and salts. The muscular tissue is composed almost entirely of nitrogenous material. There are no peptones in the living muscle, but the ferment pepsin is present. After death, by the action of pepsin in the presence of lactic acid, the muscles are partially digested so that both peptones and proteoses are found. The muscle contains not to exceed 1 per cent. of a carbohydrate called *glycogen* ($C_6H_{10}O_5$), or animal starch, which is formed from the sugars taken into the circulation from the digestive tract. There are two classes of muscular tissue, the voluntary or striated muscles, like those of the leg, and the involuntary or non-striated muscles like those of the heart.

[1] Food Inspection and Analysis, Leach, p. 211.

Slaughtering Meat

In discussing the slaughtering of meat, H. W. Wiley says[1] "The principal thing to be considered is first a sudden, and in so far as possible, a painless death of the animal; second, the immediate withdrawal of the blood of the slaughtered animal, if slaughtered otherwise than by opening the principal artery; third, the removal of the intestines and hair or hide of the animal; fourth, immediate cooling at a moderately low temperature until the animal heat is entirely radiated; fifth, the cutting of the carcass into the usual form for consumption and the removal and utilization of the débris for food or other purposes; sixth, the delivery of the meat, if to be eaten in a fresh state in a condition secured from contamination and decay until it is in the hands of the consumer; seventh, the curing of the meat in a proper manner by salt, sugar, vinegar and wood smoke, and the delivery thereof in an unadulterated form to the consumer."

Keeping Meat

After slaughtering, the meat undergoes several changes. Immediately after being killed the flesh, especially in young and well-nourished animals, is juicy and tender. On account of the clotting of the myosin, after a short time *rigor mortis* ensues and the meat becomes stiff and hard. In the third stage to which the meat soon passes, it becomes again soft and tender, owing in part to the action of lactic acid on the sarcolemma and connective tissue. This process should not, however, be allowed to go too far, or the meat will become "high" and have a disagreeable odor and flavor.

This development of the lactic acid rendering the meat tender, is called "ripening" of the meat. Refrigeration retards this process, hence meats can be kept fresh for a considerable time at a low temperature (below 40° F.). The experiments by P. F. Trowbridge,[2] show that as long as the amount of lactic acid continues

[1] Foods and Their Adulteration, Wiley, p. 14.
[2] Missouri Agri. Exp. Sta.

to increase the meat appears to be improving in quality. At a certain stage, however, basic bodies begin to separate, which neutralize the lactic acid and thus cause a decrease in the amount of this free acid. The meat is still edible after this decrease has begun, but whenever enough basic bodies are liberated to neutralize the lactic acid, the meat has then reachd a stage of incipient putrefaction and is no longer fit for food.

Game is often allowed to "hang" until the changes of decomposition are well marked and in this condition it is highly relished by epicures.

Chemical Composition

The different cuts of beef differ quite widely in composition, dependent on the location of the "cut," and the quality or grade of beef. This is well illustrated in the following analyses taken from Mo. Ag. Ex. Sta. Bulletin:

A VERY HIGH GRADE OF BEEF

	Moisture	Fat	Protein	Ash
Chuck, exclusive of bone	58.33	25.03	16.38	0.76
Round, lean tissue only	69.51	9.21	20.05	0.98
Round, fat tissue only	16.61	78.03	5.66	0.24
Loin, lean tissue only	66.92	12.22	19.07	0.95
Loin, fat tissue only	11.62	84.91	3.33	0.16

ORDINARY COW, RATHER LOW-GRADE BUTCHER'S STUFF

	Moisture	Fat	Protein	Ash
Chuck, lean tissue only	70.01	9.18	20.04	0.95
Chuck, fat tissue only	20.50	72.72	6.96	0.28
Round, lean tissue only	72.67	5.34	21.15	1.05
Round, fat tissue only	27.91	60.97	10.49	0.42
Loin, lean tissue only	69.35	9.08	19.51	0.99
Loin, fat tissue only	13.55	80.99	5.98	0.20

The flavor of meat depends on the amount of nitrogenous extractives—the creatin, creatinin, xanthin, etc., present. The amount of these "meat bases" is small—from 4 to 15 grains only per pound in ordinary meats. When these are removed by boiling, the meat is almost without flavor. Only a trace of the nitrogen present is in the albumoses and peptones. It is stated that not far from half of the nitrogen in water-soluble flesh consists of the extractives and half is coagulable proteins.

Cooking Meats

The cooking of meats has been very thoroughly studied.[1] Among civilized people meats are usually cooked before they are eaten, because this process improves the taste and makes them more palatable, injurious animal parasites and bacteria are destroyed and finally since the tissues are thoroughly softened so that they can be more readily attacked by the digestive fluids. In the process of roasting or boiling a moderately large piece of meat, the interior never reaches a temperature above 190–200° F.[2] The time required to roast a piece of beef depends on its size, shape, etc., and the temperature of the oven. For example, a single short rib roast containing the bone required 16.3 minutes per pound to cook the meat rare, while the two-ribbed rolled roasts averaged 20.1 minutes at the same temperature to reach the same conditions. If the roast is quite completely covered with fat, the heat penetrates only through the lean portions exposed.

Roasts are as quickly cooked at an oven temperature of 175° C. (347° F.) as at 195° C. (383° F.), so the higher temperature involves a waste of fuel. There is much less danger of overcooking the meat at the temperature of 100° C. (212° F.), than at a higher temperature, but of course a much longer time is required to raise the temperature of the interior. By slow cooking, however, the interior is in a much more uniform condition.

[1] U. S. Dept. Agric. Office Exp. Sta. Bul. No. 162.
[2] Bul. Univ. Ills. Vol. 55, No. 19; U. S. Dept. Agric. Farmers' Bull. No. 162.

In regard to the treatment of meat with water, research shows[1] that 13.56 per cent. of the total protein existing in lean beef, is soluble in cold water. Of this soluble protein, 90.04 per cent., is in a form which is coagulable by heat from a neutral solution, 8.40 per cent. exists as albumoses, and a very small portion apparently exists as peptones. A 10 per cent. solution of salt water will extract twice as much protein from raw meat as will pure water.

In the process of cooking, raw meat loses considerable weight. As shown by Grindley[2] the average of ninety-one tests of the percentage loss of nutriment in uncooked meat when boiled for three hours is water 45.07; protein 7.25; fat 11.70; ash 44.62. In some other experiments, the actual loss in weight by boiling a piece of "round" beef was 38.32 per cent.; the loss in weight by the process of roasting was 30.10 per cent.

The chief loss during the cooking of meat is evidently that of the water.[3] When beef is pan-broiled (fried in a hot pan without the addition of fat) there appears to be no important loss of nutritious material. Beef cooked with water loses from 3 to 20 per cent. of nutrients, which is, however, found in the water as extractives and can be utilized for soup or gravy. Meat when chopped before cooking or when cooked for a long time, of course loses a greater per cent. of nutrients.

When beef is used for the preparation of beef tea it loses comparatively little of its nutritive material, although much of the flavoring substance is removed. The greater the amount of fat in the original meat, the less the shrinkage during cooking. As long as the temperature of cooking is kept below 185° F. there appears to be little difference in the amount of material found in the broth, whether the meat is plunged into cold water or into hot water at the start.

In roasting meat it is desirable that the exterior of the roast be at first seared by being placed in a hot oven, and that the process be completed at a lower temperature, if the retention of the nutri-

[1] J. A. C. Soc., Vol. 27, p. 504.
[2] U. S. Dept. Agri. Bull. No. 141.
[3] U. S. Dept. Agri. Farmers' Bull. No. 162.

ents is desired. In boiling meat better results are attained if it is plunged immediately into boiling water. A "pot roast," in which the amount of water used is small, and this is concentrated near the close of the operation, is a very satisfactory product.

THE DIGESTION OF PROTEIN FOODS

In the digestion of meat the first change is the swelling up and softening of the fibers in the stomach. The harder the connective tissue the less these fibers separate so they can be acted on by the gastric juice, and hence pounding, or chopping tough meat adds to its digestibility.

In the stomach the free HCl acts upon the proteins of the food,[1] converting them into meta-protein acid albumin ("syntonin") which under the influence of pepsin splits down with the formation of proteoses, and these by further hydrolysis yield peptones. (See table, p. 20.) This digestion of the proteins takes place mostly after the food has passed the stomach, and when it reaches the small intestine the proteins are attached by "tryspin" and "erepsin," active enzymes or ferments found in the pancreatic juice and in the intestines, to produce proteoses and finally amino acids.

The digestive products of the proteins pass on by absorption, mainly into the capillary blood-vessels, and thence to the portal vein and into the circulation of the body. There is abundant evidence to prove that the proteins may be the source for the ultimate production of carbohydrates and to some extent of fats in the body.

The following list of comparative digestibility of common protein food, will serve as a partial guide for use of these foods.[2] The most digestible are given first and the least digestible last. Oysters, soft-cooked eggs, sweet-bread, white fish, or any fish not rich in fat, chicken, lean beef, eggs (scrambled), mutton,

[1] Chemistry of Food and Nutrition, Sherman, p. 100.
[2] Thompson, loc cit.

squab, crisp bacon, fowl, tripe, lamb, corned beef, veal, ham, ducks and game, (salmon, mackerel, herring, roast goose, lobsters and crabs, pork, smoked, dried or pickled fish or meats.

Preservation of Meat

The general methods for the preservation of food have been already discussed (p. 213).

Cold storage is perhaps of more importance for meat products than for any other class of perishable foods. By its use the abundant beef and pork of the central West can be transported to the seaboard and to distant countries; the cheap beef of the South American plains can be shipped to Europe, America, or other distant countries.

Drying is particularly applicable to beef though occasionally used for other meats. "Jerked" beef is the name applied to dried beef in North and South America, and "Biltong" is the African name for dried strips of meat, especially that of the antelope and buffalo. Dried meat contains so little moisture that it will not support the life of putrefactive germs. Smoking and drying are common methods of preservation of meat. It is usually pickled in brine for a day or two before being exposed to the smoke. The creosote of wood smoke acts as a preservative of the meat excluding putrefactive germs. Various liquid preparations made from creosote, or by condensing wood smoke are used to take the place of the smoke in the preservation of meat. Pickling in a brine containing salt, saltpeter, and sometimes sugar is the common method for preserving beef and pork. Salt acts as a germicide; and at the same time seems to dry the meat as it draws out the meat juices, so that the fibers harden. It also prevents the development of the eggs of various insects. Saltpeter (KNO_3) is used to cause the meat to retain its fresh, reddish appearance but an excess is injurious and it hardens the meat even more than salt. Pickling with borax or borax and salt is also common, and may be allowed if the borax is entirely removed by soaking out before the food is cooked.

Meat prepared for the English market is usually treated with borax in addition to other preservatives. In the United States the use of borax in meats intended for interstate commerce is not permitted.

CANNED MEATS

The portions of the carcass used for canning depends on the demands of the trade and the condition of the market for fresh meat. The meat used for this purpose is, in the United States,

FIG. 53.—Preparing pig's tongues for canning, under the supervision of a U. S. Inspector. (By permission U. S. Dept. Agric.)

under government inspection,[1] in all establishments whose products go into foreign or interstate commerce. (Fig. 53.) Both ante-mortem and post-mortem examinations are made by the Government inspectors at the time of slaughter, and carcasses that are unfit for food are sent to the "tank" department to be worked up into fertilizers. The meats to be used for "curing," making sausage or chopped meats, for making of lard and tallow,

[1] U. S. Dept. Agri., Bur. An. Ind. Order No. 137.

and for canned products are reinspected when they enter these departments. These regulations apply only to the meat of cattle, sheep, swine or goats.

The Process of Canning Meats[1]

Pieces of meat of about equal size are selected for canning, so that they may be uniformly sterilized in the process. The first

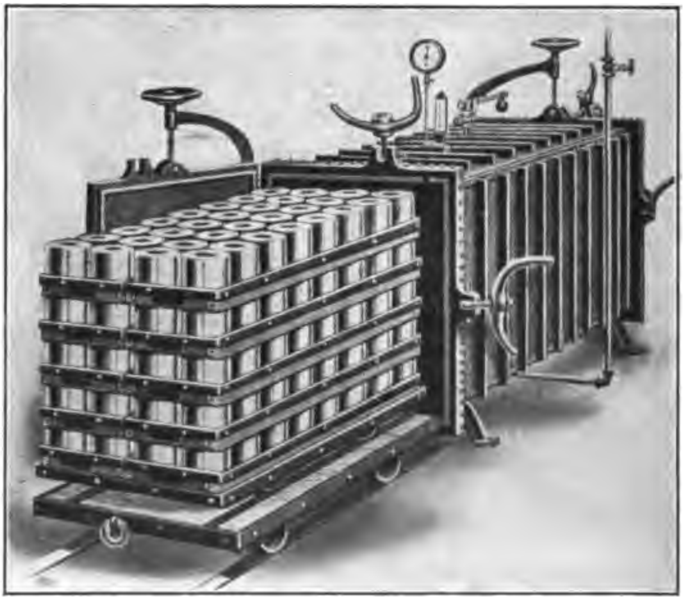

FIG. 54.—Sterilizing cans of meat under pressure. (By permission L. S. Bushnell.)

process is parboiling or partially cooking, which causes a shrinkage to about two-thirds of the original volume and at the same time extracts some meat bases, protein and mineral salts. (See p. 346.) This process is, on the whole, an advantage as it concentrates the nutrient material. The meat is then put in the tins with a small quantity of "soup liquor" which contains, in addition to some

[1] Foods and Their Adulterations, Wiley.

animal extractives, salt and sometimes sugar or molasses, and fills up the "voids" between the pieces of meat. The tins are then closed and the covers are soldered on, a hole being usually left for the escape of the gases or air inclosed within the can. The

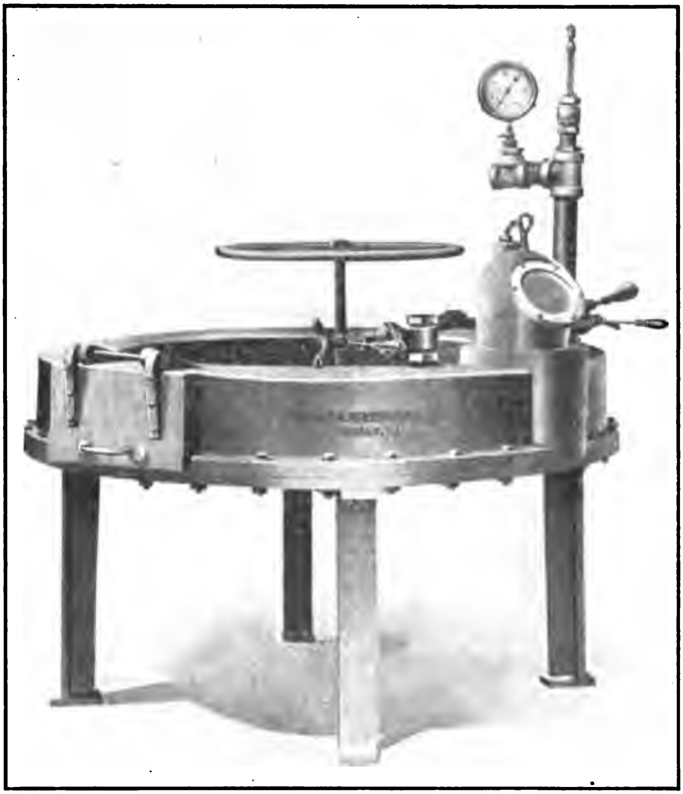

FIG. 55.—Sealing cans of meat in a vacuum.

filled cans are sterilized by heating with steam in strong boilers under pressure. (Fig. 54.) After some time the cans are hermetically sealed by a drop of solder, and then "reprocessed" at a temperature of 225° to 250° F. for one or two hours.

In some establishments the filled cans are placed in a machine where they can be exhausted in a vacuum (Fig. 55), sealed automatically while in this exhausted state, and then removed to a bath of oil or some other liquid when they are heated to a temperature of 240° F. for as long a time as seems desirable. Experiments made in the laboratories of the U. S. Department of Agriculture show that "a can of 26.9 ounces of beef contains as an average content an amount of meat equivalent to 42.1 ounces of fresh beef, and retains practically all of the nutrient value of the larger quantity of fresh beef.

Ham and bacon are canned for use in tropical climates or in sections remote from the market. The canned tongues of cattle, calves, sheep, lambs, and swine, are extremely popular and find a ready sale. They are often pickled previous to canning.

POTTED MEATS

Potted and "deviled" meats in great variety are an output of the packing houses. The term "potted meat," is like the name of a proprietary food or medicine, and conveys to the customer no idea as to the contents of the package. The consumer is not always sure that the can contains the exact meat that the label names, but if the flavor and quality are satisfactory he usually does not complain. These products are really made up of several kinds of meat such as beef and pork, and are spiced and flavored in such a way as to be agreeable to the palate.

"Deviled" meats offer still greater latitude for mixing as they consist of the ground meat mixed with spices and condiments. There is no objection to this class of goods if they are made from material that is sound and sanitary, and prepared in establishments free from infection, and if there are no fradulent additions to increase the weight, and no injurious preservatives or coloring matters added.

SAUSAGES

Any standard adopted to regulate the composition of sausage must be very broad, so that no really wholesome meat shall be excluded by it. Sausage may be made from the meat of neat cattle or swine and may be fresh, salted, pickled or smoked, with the addition of salt, spices, edible fats, blood or sugar. It contains no more water than does the normal meat from which it was prepared. If casings are used they must be preserved with salt only and not artificially colored.

Next in importance to the use of meat of an improper character in the way of adulteration is the use of starch or flour as a "filler." This increases the bulk and weight of the goods and prevents shrinkage when the sausage is cooked, and moreover starch is much cheaper than meat, so a greater profit can be made. In some States a product called "cereal sausage" is allowed, if it does not contain more than 2 per cent. of cereal, and if the composition is plainly marked on the package. Boric acid or borax and sodium sulfite, are preservatives that have been frequently used in sausage, especially canned.

Varieties of Sausage

The varieties of sausage made, especially in Germany, are very numerous; more than 40 might be readily described. Among these may be mentioned pork sausage which is put into casings consisting of the intestines of cattle, sheep or swine; bologna, in which the chopped meat is put into casings, boiled, smoked and dried; polonies which are a favorite in England, and are usually put in colored skins; rothwurst, similar to the English "Black pudding," made from pork, often with the addition of blood, heart or kidney, and spices and starch, put into skins and boiled; mett wurst, made from pork, with large additions of lard and frequently beef and horse-flesh; cervelatwurst, made from the brains of pigs and horses, with the addition of pork and lard; leberwurst, made from the livers of pigs and calves, sometimes with pork and lard and occasionally the lungs and starchy matters; magenwurst, made from the stomach, skin and other parts of the pig, with blood and unsalted bacon; bratwurst, made from raw pork and bacon, with lemon and cumin as flavorings; erbswurst, which contains suet, bacon and pea flour, and is seasoned with onions and spices; frankfurter sausages, which are small and made from raw pork well seasoned.[1] Often the casings or skins are artificially colored and frequently some preservative is used.[2]

"MINCE MEAT"

Mince meat is a mixture of not less than 10 per cent. of cooked comminuted meat, with chopped suet, apples, and other fruit, salt and spices and with sugar, syrup and molasses, with or without vinegar, fresh, concentrated or fermented fruit juices or spiritous liquors, according to the standard of many of the States. Mince meat is used as filling for pies. Meat is not always found in mince meat and corned beef is sometimes substituted for fresh meat, and evaporated or dried fruits are also used in the place of fresh fruits. Boiled cider or brandy is a common addition to the mixture.

Some manufacturers put on the market a pressed mince meat which is similar to the above, except that it contains starch or flour as a "binder." This also increases the weight and absorbs the superfluous moisture.

Both these forms of mince meat are readily adulterated, not only by the use of meats and other constituents that are unfit for food, but by the use of sodium benzoate as a preservative. Mince meat is one of the products that can usually be made more cheaply at home, and the conditions there prevailing will insure its being clean and wholesome.

SOUP—BEEF TEA—MEAT EXTRACTS

Soups may be of animal or of vegetable origin. Their use at the beginning of a meal has a foundation in dietetic experience, as a soup or bouillon is simply a warm, slightly nutritive liquid of agreeable taste, which stimulates the secretions of the stomach to greater activity.

[1] Foods and Drugs, Parry, Vol. 1, p. 386.
[2] J. Soc. Ch. Ind., Vol. 33, p. 947.

"Soup stock" may be made by first cutting the meat into small fragments and breaking the bones into pieces. It is well to note that the smaller the pieces of meat the greater the surface exposed, and the more thoroughly the juices will be extracted. Sometimes the meat mixed with sufficient water and salt, is heated in a vessel with a tight cover, so that the pressure can be raised above that of the atmosphere, with a temperature correspondingly higher. If an ordinary vessel is used the meat should be simmered for some time, then allowed to cool, so that the excess of fat can be skimmed off. This product when strained and properly flavored constitutes what is known as consommé. From 5 per cent. to 8 per cent. of the constituents of the meat, consisting of soluble albumin, gelatin, extractives, mineral matter and flavoring material will be found in this broth. The analysis of a large number of home-made and canned soups shows that they contain from 2 per cent. to 6 per cent. of protein, from 0.1 to 4 per cent. of fat, and from 0.2 to 8 per cent. of carbohydrates.

If the soup is intended simply for a first course, to stimulate the appetite it may be a "clear soup" or one only slightly thickened like consommé, bouillon, chicken broth, mulligatowny or ox-tail soup, but if it is to constitute an important part of the meal, its nutritive value should be increased by thickening with pea-flour, or lentil-flour, or the addition of peas, lentils, macaroni, vermicelli, parsley or vegetables cut in small pieces.

Bouillon Cubes—Soup Tablets

In making the best grades of soup tablets the meat is extracted at a low temperature, so as to avoid the coagulation of the albumins, the liquid is strained at 200° F. and, after being properly flavored and seasoned, is concentrated until a portion will coagulate on cooling, and is then poured into molds to set. Sometimes these soup tablets are made without meat, from the gelatin obtained from cartilaginous tissues such as calves' feet, tendons, etc., properly flavored, and colored with caramel.

According to recent investigations, by F. C. Cook,[1] the bouillon cubes on the market contain from 49 to 72 per cent. of common salt; from 8 to 28 per cent. of meat extract; and from 3 to 30 per cent. of vegetable extract. In the poorer brands of cubes the amount of meat extract is very small and the quantity of common salt is large. These cubes are by no means, as many believe, concentrated beef or meat essence, but really stimulants or flavoring agents, relatively expensive. Homemade meat broth and homemade meat and vegetable soup provide much more meat extractives, protein, and fat at much less expense, than the commercial preparations.

MEAT EXTRACT

There is upon the market a large variety of products of the meat extract class, such as solid extract, liquid extract, beef tea, beef juice, soluble meat, meat essence, yeast extract, meat powder, bouillon cubes, peptone and numerous proprietary preparations.[2]

Semi-solid meat extracts and fluild meat extracts are to be regarded as stimulating and flavoring adjuncts only. The latter are more expensive than the former, as they contain more water and frequently cost as much.

Since these products first became known through the investigation of the German chemist Liebig and their manufacture in South America where cattle were cheap and abundant, they have become of great importance to the physician and are often prescribed as a part of the diet of his patients. Beef extract is really nothing but soup stock, made under special conditions from beef. About 34 pounds of meat are necessary to yield 1 pound of concentrated extract,[3] and this extract may be diluted to make 6 or 7 gallons of beef tea. This statement does not however imply that this pound of extract contains as much nutriment as 34 pounds of beef, as that is far from true. According to the

[1] Bull. Dept. Agri., No. 27, 1913.
[2] U. S. Dept. Agri. Bur. Chem. Bull. No. 114.
[3] Loc. cit., p. 14.

Standard of the U. S. Dept. Agri. meat extract should not contain less than 75 per cent. of total solids.

Food Value of Beef Extract

The analysis of a solid beef extract shows that it contains about 50 per cent. of soluble nitrogenous constituents of meat and more than half of this is the meat bases such as creatin, creatinin, xanthin, etc. These substances do, it is true, have a stimulating effect, but they possess very little nutritive value. They are, in fact, bodies which are "far on their way" to form urea, one of the substances excreted from the body. Very little of either creatin or creatinin will be utilized in the body, if taken with the food. Although they are nitrogenous substances, yet their composition is such that they do not add to the nutritive value of extracts or soups containing them.

Hutchinson,[1] in speaking of the meat extractives says "The recent experiments of Powlaw have shown that they are the most powerful excitive of gastric secretion that we possess. They are thus eminently calculated to rouse appetite, and aid digestion of any food with which they may be taken. This is indeed their true rôle, both in health and disease. They are *flavoring agents*, and their proper place is in the kitchen and not by the bedside." The meat from which the extractives have been removed, is tasteless and consequently difficult of digestion. The small quantity of nutrient material in beef extract, may be of value in some cases where it is of great importance to have a little nutriment even if the amount is very small, readily absorbed.

BEEF JUICE

Beef juice is a different product from beef extract, in that it should be the juice of the *raw meat* extracted simply by pressure. Cold water is often used with the finely chopped meat, and the

[1] Foods and Dietetics, Hutchinson, p. 93.

juice is afterward sterilized so that it will keep without decomposition. Artificial preservatives should not be used in this or in any of these beef products, as they are designed especially for the use of invalids whose digestion may be weak.

BEEF TEA

For domestic use "beef tea" can be readily prepared by allowing the finely chopped meat with a little salt to stand in cold water for half an hour, and then heating for some time in a double boiler at a temperature always below 160° F. The juice may then be poured off, and the meat pressed to remove as much juice as possible. When cold, the fat, if any, is removed from the top. The flocculent sediment contains most of the nutriment. The domestic beef tea prepared shortly before use is much more satisfactory than any commercial preparation. An excellent quality of home-made beef juice is prepared by slightly broiling small pieces of meat, and then expressing the juice by the use of a hot lemon squeezer. This juice should be seasoned and served while still hot. Meat juices contain the soluble and liquid proteins in an uncoagulated form, and are therefore better adapted for digestion than when coagulated by heat. Gelatin is sometimes present in meat extracts, although the manufacturers of the best products try to avoid it as much as possible. (See p. 359.) Some of these commercial beef extracts and juices are of such a composition as to indicate that they are prepared chiefly from blood, rather than from meat juices, some are enriched by the addition of raw egg albumin, and the products, although sold at a very high price, often contain an excess of common salt.

SOLUBLE MEAT

"Soluble meat" is prepared by treating the comminuted meat with dilute hydrochloric acid and pepsin under pressure or with HCl and steam. The object of this process is to begin the digestion by converting the meat into proteose or peptone and to retain the extractives. Although there may be instances in which such a product is of value in the diet, ordinarily it is better to require the digestion to take place within the body, by natural methods.

DRIED OR POWDERED MEAT

Powdered meat preparations under various names have been placed on the market. They consist largely of albumoses rather than peptones.[1] The "pemmican" of the northern "voyageur" is a product of this class and serves a very important purpose when the weight and bulk of the provisions transported must be considered. Dried meat powder is sometimes useful in artificial feeding to supplement a soup stock low in nutritive protein.

GELATIN

Gelatin, another meat product which has come into quite general use, is prepared from the bones, hides, tendons, horns, piths and hoofs of animals by boiling them under pressure. Collagen, which composes the fibers of connective tissue, is one of the chief sources of gelatin, into which it is transformed by boiling. If bones are used in the process of making, they are crushed and treated with hydrochloric acid to remove the inorganic salts. This mass is then mixed with the softer material used, and soaked with lime or soda for two or three weeks to dissolve out the fat. The mess is finally washed and steamed to remove the gelatin, and sulfurous acid is used in bleaching the product. It is then solidified in layers, redissolved, washed free from acids, and dried at a low temperature. If prepared under good sanitary conditions, and from material which was in the beginning fit for food, there is no objection to the use of gelatin as a food material. The impure, unpurified gelatin is known as "glue."

Gelatin swells readily in cold water and as small a quantity as

[1] Foods and Their Adulteration, Wiley, p. 85.

one per cent. will set into a jelly, although the ordinary jelly contains about 2 per cent. It has come into popular use, because of

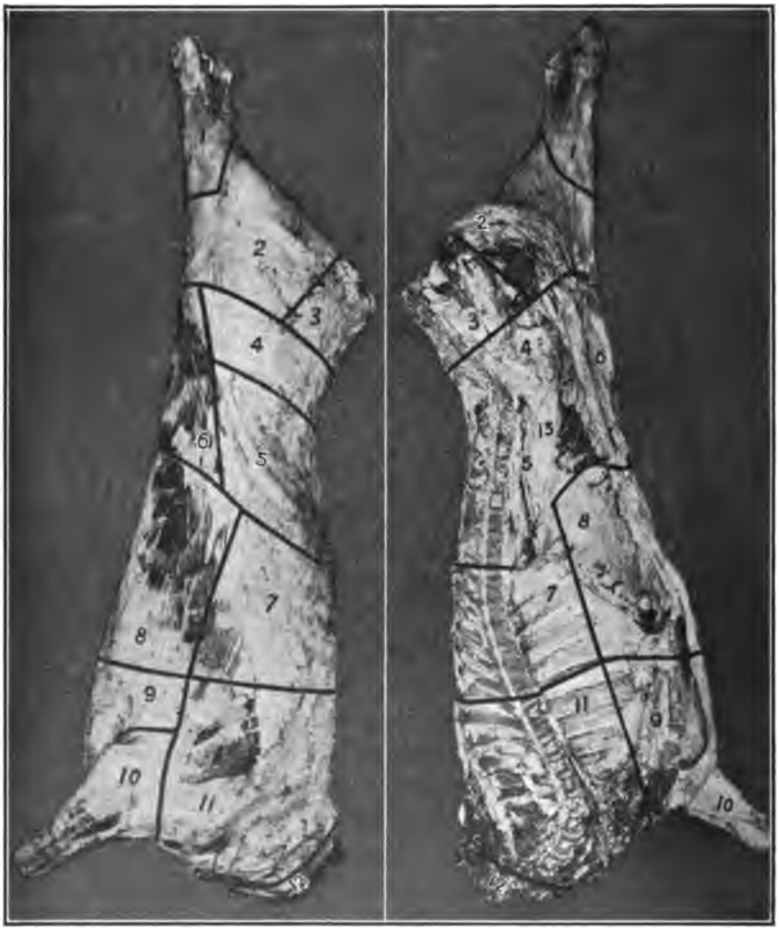

Fig. 56.—The ordinary commercial cuts of beef are as indicated in Fig. 56 and are named as follows: 1, Shank; 2, round; 3, rump; 4 and 5, loin (4, sirloin; 5, porterhouse); 6, flank; 7, rib; 8 and 9, plate (8, navel plate; 9, brisket); 10, shin; 11, chuck; 12, neck; 13, suet. (By permission Dept. of Agric. U. of Mo.)

this property, and because it can be sweetened and flavored, and made into numerous appetizing and decorative dishes. In regard to its nutritive qualities some authors believe that it has a value in stimulating the flow of gastric juice, and while not a tissue former it has the property of sparing the protein tissues from destruction. It is evident that the nitrogen in gelatin is not present in a form available to the body as in true proteins.[1]

BEEF

In the United States for commercial use, the carcass of the beef cattle is usually cut as illustrated in Fig. 56.

These different cuts, exclusive of bone, have only a slightly

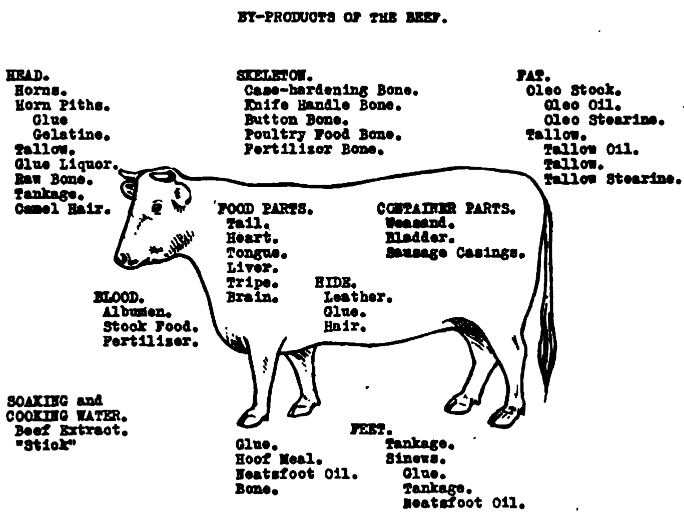

FIG. 57.—(By permission Armour Packing Co.)

different food value, but on account of their other qualities such as flavor, shape and tenderness, sell at retail prices ranging from 5 cents per pound for a soup bone to 45 cents for the best sirloin steaks. In the United States these prices differ very much in the different sections. The large cities are supplied mostly by the packing houses, while the rural population is supplied in part by

[1] U. S. Dept. Agri., Bur. Chem. Bull. No. 114.

local abattoirs. *Veal*, although very much in favor in many countries, especially in Germany, has not been considered as wholesome or as easily digested as beef. It contains more gelatin and less fat than the latter, and some believe if used in too large quantities is liable to cause intestinal disturbance. There has been a common prejudice against the use of very young veal, but recent experiments indicate that the meat is just as easily digested as that of older calves.[1] Its use seems to produce no laxative effect, and in no way affects the health of normal individuals.

PORK

Domestic swine are the descendants of the "wild boars" that formerly inhabited the forests of the Eastern Hemisphere. They are raised in great numbers in those parts of the United States where corn (maize) is readily grown, also in the South where they are fattened with peanuts, and are shipped to the packing houses in Chicago, Kansas City, Omaha and other large cities.

The ordinary cuts of swine are somewhat different from those of beef, as so much of the former is utilized for salt pork and bacon. The hams and shoulders are used for pickling and smoking. From the top of the back and the belly are obtained the cuts used for salt pork. "Spare ribs," "chops" and roasting pieces are obtained below the "back cut." Leaf lard is made from the kidney fat, found inside the back.

The illustration (Fig. 58) shows the common method of cutting up the hog.

Although many believe that pork is a much less desirable food than other meats, it is very extensively used by all classes of people the world over. When the hogs are raised under sanitary conditions with good, wholesome food, there is less objection to the use of the meat than when they are fattened in filthy surroundings, and fed with brewers' slops or other refuse. Hogs are subject to comparatively few diseases, and these, such as hog-cholera, usually

[1] J. A. M. Ass. Vol. 60, p. 834. Also (Fish) Am. Vet. Rev., 41, p. 178.

carry them off quickly. Pork, ham and sausage are sometimes infested with *trichina spiralis*, which may be seen encysted in the flesh. If the meat has not been carefully inspected at the

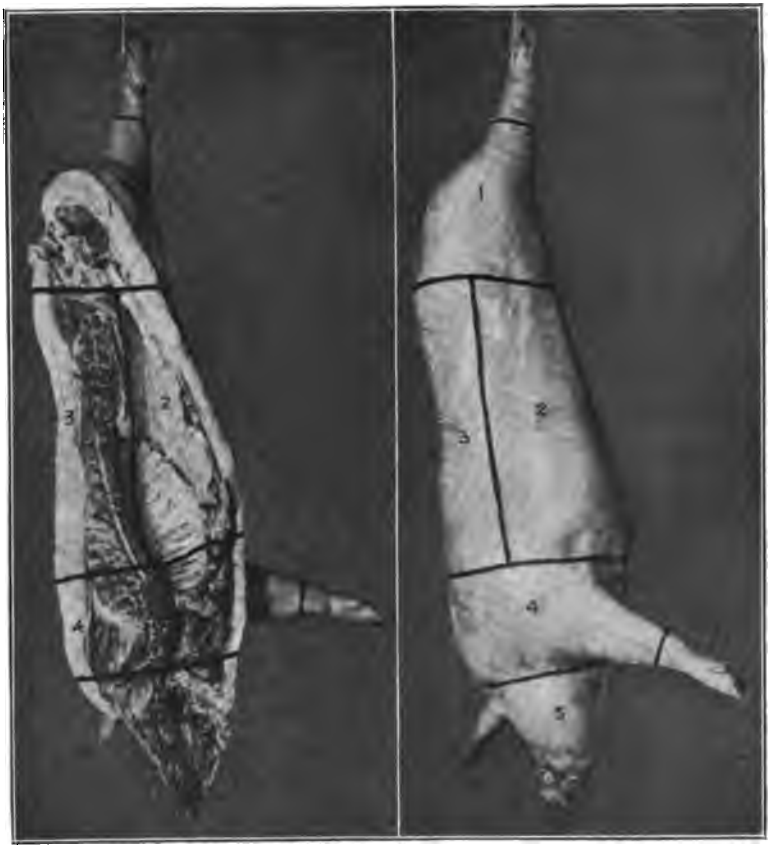

FIG. 58.—Commercial cuts of pork. (By permission Dept. of Agric. U. of Mo.) The ordinary commercial cuts of pork are named as follows: 1, Ham; 2, bacon (spare rib, leaf lard); 3, fat of back (loin); 4, shoulder; 5, jowl, plate.

time of butchering by competent veterinarians the only safety is in a thorough cooking so as to destroy the parasites. Merely boiling a large mass of meat, as a ham, is not sufficient for this purpose, as the interior is seldom heated to a high enough temperature. The use of raw sausages especially should be discouraged.

MUTTON

The cuts of mutton are different from those of beef and pork, and are usually six in number, three on each side of the carcass. The hind quarter of lamb is the favorite portion for roasting. The "chops" are the short ribs with adhering flesh.

By many physicians, mutton is considered the most easily digested of all the meats. Mutton fat, however, is liable to cause gastric disturbance, which may be attributed to the fact that it contains more stearic acid than beef fat, and is therefore of firmer and more compact structure, but the nutrient qualities of the two kinds of meat are the same. The best English mutton is obtained from animals six years old,[1] and in any case the animal should be three years old before it is slaughtered. The characteristic flavor of mutton is modified by cooking with a little vinegar or lemon juice, and some consider that the flavor is improved by this treatment.[2]

GOATS

The meat of goats and kids is not used extensively in the United States, although it is an important food with many European and Asiatic people. As these animals live and seem to thrive on steep rocky lands, where the amount of forage is limited, they are of great value for their milk, their skins and their flesh, to those who live in rough mountainous localities. The flesh of goats, with the exception of the angora, is not as palatable as that of the sheep.

HORSE FLESH

The meat of the horse is seldom used knowingly in the United States, but forms a very important part of the diet in France,

[1] Practical Dietetics, Thompson, p. 119.
[2] U. S. Dept. Agri., Farmers' Bull. No. 526.

Germany, Austria, Russia, and Denmark. Whenever from any cause other varieties of meat become scarce it has in various countries been found convenient to use horse meat.

This meat is liable to be somewhat tough and coarse, largely due no doubt to the fact that horses are raised for purposes other than food, and are usually old and worn out before they are slaughtered. The beef from old draught cattle or of cows is not nearly as good as that of the young steer which has been specially fattened to serve as food. Horse meat does not differ materially in composition from beef, except that it contains a relatively large amount (about 1.8 per cent.) of a peculiar starch called glycogen. (See p. 14.) A high per cent. of this substance is indicative of the presence of horse meat and a method based on this fact is used in detecting horse flesh when mixed with other kinds of meat, as in sausages. The fat is also of characteristic composition and structure.

BIRDS (POULTRY)

Besides the various wild fowl or game birds that are used as food, the more common domestic birds are chickens, ducks, geese, and turkeys. The most important of these are the ordinary chickens, supposed to be descended from the red jungle fowl of India or the East Indies. "Spring chickens" are considered fit for food when they are from two to three months old, but the old fowls are apt to be so tough and flavorless as to be very unsatisfactory food. Within the past few years the chicken business has been carried on very scientifically in many localities, and by the use of the "incubator," in which the temperature is kept constantly at about 102° F., the eggs are hatched as desired so as to have chickens ready for market at any time of the year.

Fowls which have been allowed to hang from one to two days are considered better for food purposes than those that are freshly slaughtered; they may of course be kept for a longer time at a low temperature as in cold storage. There has been much discussion[1] as to whether the chicken should be stored and marketed "drawn," that is with the viscera removed, or whether the intestinal organs should be allowed to remain in the fowls. In some states the regulation of the food authorities requires that only drawn poultry shall be stored or put upon the market, but at the present time there is little objection to shipping undrawn poultry. A time limit should be put upon the keeping of poultry in cold storage."

By the castration of the male bird at an early age, the "*capon*" is produced and its flesh has come to be very highly prized especially in Europe, on account of its more delicate flavor.

The composition of white meat and dark meat of chicken is as follows:[2]

	Water	Water in fat-free substance	Fat	Protein	Meat bases
White meat	61.38	75.08	18.45	17.06	0.37
Dark meat	59.48	78.44	24.16	15.04	1.03

The white meat does not contain so much fat, but does contain more protein, and is better suited for the diet of invalids. The dark meat, on the other hand, contains more meat bases, consequently it has more of the characteristic flavor of the chicken. The potted chicken found on the market was formerly quite largely adulterated by the substitution of other meats.

DUCKS

The meat of the domestic duck, as well as that of the wild duck, is used for food all over the world. There are many varieties of ducks, and the composition of the flesh differs within wide limits. Mallards, canvas back, and teal, are some of the wild varieties found in the United States.

[1] Ill. Bull., Dept. Agri.
[2] Foods and Their Adulteration, Wiley, p. 102.

GEESE

The common goose of the barn yard is probably a descendant of the wild geese which lived in early times in the marshes and fens of the countries surrounding the Mediterranean Sea. In some countries the goose after it is killed is allowed in winter to hang for several weeks before it is considered suitable for comsumption. Great care is exercised in fattening geese for the market, and they are given all the food that they will eat, and are carefully protected from cold weather. The artificial fattening of fowls has been recently developed in such a way that the food is actually stuffed into the œsophagus of the fowl by the use of a suitable machine. "Pâté dé foie gras," a favorite delicacy in parts of France and Germany, is prepared largely from the overgrown livers of geese that are stuffed in this way so that the liver often weighs 2 or 3 pounds. These pâtés as found on the market are apt to be adulterated by the partial substitution of other meats.

TURKEYS

The domestic turkey is a descendant of the wild turkey of the plains of North America. Turkeys are not so easily raised as other fowls, being more subject to disease. They are seldom eaten while young, and have the advantage of not being tough when they reach full maturity. They are often found in the markets in the United States, especially late in the autumn, weighing from 20 to 25 pounds. There is little difference in composition between the meat of the turkey and the chicken.

CHAPTER XV

FISH AND SHELL FISH

Since fish are abundant in both fresh and salt water, they have from the earliest times been a favorite food, indeed fish often forms the staple food of a large class of people. Many partially civilized tribes and the inhabitants of distant islands, as well as those who patronize the itinerant "fish peddler," have learned the value of fish as a cheap and wholesome source of nutriment. In fact, fish takes the place of meat to such an extent that in many countries it is used to the entire exclusion of other nitrogenous foods. Taken weight for weight, however, fish, as it contains more water, is less nutritious than other meat.

Composition of Fish

That there is considerable difference in the composition of different kinds of fish is illustrated by the analyses of a few varieties here given:[1]

Edible portion	Water	Protein N×6.25	Fat	Ash
Bass	77.7	18.6	2.8	1.2
Blue fish	78.5	19.4	1.2	1.3
Cod	82.6	16.5	0.4	1.2
Herring	72.5	19.5	7.1	1.5
Mackerel	73.4	18.7	7.1	1.2
Shad	70.6	18.8	9.5	1.3
Trout	77.8	19.2	2.1	1.2
Whitefish	69.8	22.9	6.5	1.6

[1] U. S. Dept. Agri., Office. Ex. Sta. Bull. No. 28.

The refuse in fish as purchased, which includes the head, fins, skin and bones and interior organs, amounts to from 50 to 60 per cent.

Classes of Fish

The proportion of fat is less in fish than in other nitrogenous foods, but there is a very marked difference in different varieties, so the fish may be classified according to their fat content, thus:

1. Fish with more than 5 per cent. of fat, as eels, 18 per cent.; salmon, 12 per cent.; turbot, 12 per cent.; and herring, 7 per cent.

2. Fish with from 2 to 5 per cent. of fat, as halibut, 2 per cent.; black fish, 2.8; menhaden, 3.9; white perch, 4; average of white-fleshed fish, 2.90.

3. Fish with less than 2 per cent. of fat; as cod, 0.36, flounder, 0.63; haddock, 0.30; pickerel, 0.50; red snapper, 1.00; whiting, 0.50; sea bass, 0.50. Fish of this latter class are especially easy to digest.

It will be noticed from the analysis that the amount of water in fish is larger than in meats. While this reduces the nutritive value, it may tend to make fish more digestible. The dry matter of fish is rich in protein; sometimes richer than dry meat. The nitrogenous constituents also contain more gelatin and less "extractives" than do those of meat. This greater richness in those substances that yield gelatin causes fish to lose more on boiling then meat, and is one reason why boiling is not the best method of cooking fish. As the extractives are low, fish has not the attractive flavor of meat, and a fish diet is more apt to become monotonous.[1] The mineral constituents of fish, especially the phosphates of calcium and potassium, are high, and there is considerable sodium chloride (common salt) present. The "fuel value" of fish, as purchased, is low on account of the large amount of water, and the waste in dressing. It varies from 220 for dressed cod to 475 for halibut steaks.

[1] Food and Dietetics, Hutchinson, p. 80.

Digestibility of Fish

Investigations upon the digestibility of fish lead to the conclusion that it is more rapidly and just as completely digested as meat. As lean meat is more easily digested than fat meat, so lean fish is much less liable to cause derangement of the digestive system than fat fish. Cod fish, however, although one of the leanest of fishes, has such coarse fibers that it is not as readily digested as most fish of this class. The muscle of salted fish is hardened by the process of preservation, and consequently salt fish is not as readily digested as that which is fresh.

Because fish are less stimulating and "lighter" than meat, they constitute an excellent diet for brain-workers and those of sedentary habits. On the other hand these same qualities militate against the use of fish to entirely replace meat in the diet of the working man. It is found that fish, while it satisfies the hunger for a time, does not appease the appetite as long as does meat; the hunger soon returns.

Fish alone is not well adapted to the production of energy, but should be supplemented by bread and butter and potatoes or other starchy food. The "cod-fish" cakes" of New England, which are made from fish and potatoes, or bread crumbs, and are usually fried in pork fat, constitute a fairly well-balanced ration. In many localities fish are a cheaper source of protein than meat, and the lack of fat can be made up by serving them with a sauce of drawn butter, or by the use of some other fat-containing food. Notwithstanding the enormous quantity of fish obtained in the United States the amount of fish imported in 1912 was valued at ver $14,000,000.

Varieties of Fish

A few only of the more important fishes are here discussed. As in many cases their characteristics are so well known a detailed description is unnecessary.[1]

[1] Foods and Their Adulteration, Wiley.

The **anchovy**[1] is a small fish found along the coast, in rather warm waters both in Europe and America. They are eaten pickled often as a relish more than in a fresh state. Anchovy sauce—which is made by pounding the fish in water and simmering with pepper, salt and other seasoning—and anchovy paste, are favorite dressings.

Black bass is one of the best North American fresh water fishes. It is found in many streams and lakes in the north, and is one of the fish that has been most extensively propagated by the U. S. Government.

The **blue fish,** which is found in the market weighing from 3 to 5 pounds, is one of the favorite salt water fishes along the Atlantic coast.

The flesh of the **German Carp,** a fresh water fish, is rather coarse and lacking in taste, although it is probably as nutritious as that of other fish.

The **catfish** or **"bullhead"** is common in muddy streams and ponds throughout the United States. Some varieties found in the Mississippi and its tributaries attain a weight of 150 pounds and are 5 feet in length. The flesh is sometimes rather coarse and has a strong taste especially if the fish is grown in a muddy stream. The edible portion of the catfish contains on the average 20 per cent. of fat, and on this account the flesh of one species is sometimes used in certain parts of Europe in the place of lard.[2]

The **codfish** of the Newfoundland Banks is one of the most valuable salt water fishes. Not only is it an excellent food when fresh, but when dried and salted it forms a staple in some parts of the country. The livers of the cod are extensively used, especially in Norway, as a source of cod liver oil. This fish has also been largely propagated by the U. S. Bureau of Fisheries. The haddock, which is related to the cod, is abundant along both the Atlantic and Pacific coasts of North America, and is eaten either fresh or after being salted and smoked. "Finnan Haddies" are

[1] American Food and Game Fishes, Jordan and Evermann.
[2] Foods, Their Origin, Composition and Manufacture, Tibbles.

haddock which have been soaked in strong brine for thirty minutes and are then exposed to the smoke from a peat fire for several hours.

The **halibut**, which is one of the largest of the food fishes, is found in great abundance in the north Atlantic and north Pacific. Its weight sometimes reaches 500 pounds, although much smaller specimens are better for food purposes. Halibut steak is common on the markets both in Europe and America. As the flesh contains a good proportion of protein and a moderate quantity of fat, it forms a better balanced ration than codfish.

Herring, of which there are many different genera and species, are essentially salt water fish. Their habitat is especially the cool waters of the northern seas, where they grow in great abundance. Herring fisheries are found on the coast of Denmark, Norway, Belgium, France and the United States. This fish is sold either fresh or preserved by pickling, salting or smoking. "Bloaters" are dry, salted herrings afterward smoked. "Kippered" herring are soaked in brine for a short time, and then smoked over hard-wood shavings.

The **mackerel** is found in great abundance along the Atlantic coast, especially in the North, and southward to the Mediterranean and Adriatic seas. They travel in immense schools, sometimes several miles in extent. Like most other fish that are found in great abundance, they are used both fresh and salted or smoked. The flesh is comparatively rich in fat, and is therefore not as readily digested as that of some other fish. The "Tunny" or "tuna" fish is the largest of the mackerel family, and sometimes grows to the length of ten feet. The flesh is of excellent quality so it is a popular fish for canning purposes. The **pompano**, which is also related to this family, is found especially in the Gulf of Mexico. It is a fish weighing only 2 or 3 pounds, but its delicate flavor makes it of special value.

The Mullet is a widely distributed species, found along the Altantic coast especially off the Southern States. This fish, which sometimes reaches a length of 2 feet, is not very particular about its food, being in fact something of a scavenger, but is an important food fish.

The **salmon** is by many considered the most valuable of the food fishes. It was an important article of food even in the days of the Romans, and we read that in ancient times both England and Scotland supplied central Europe with this fish. Five distinct species are found along the Pacific coast of America, where they begin to run up the large rivers to spawn early in the spring, and may be caught during the greater part of the summer. After spawning, strange as it may seem, in a short time they inevitably die.[1] The flesh of different species varies in color from almost white to deep pink, and as it contains about 17 per cent. of protein and an equal quantity of fat, forms an extremely rich and nutritious food. The salmon found on the Atlantic coast contain less fat and more protein than the Pacific variety. Salmon are put upon the market fresh, frozen, and in immense quantities canned.

Sardines, or **pilchards,** which belong to the herring family, are found along the coast, both of Europe and North America, especially in northern waters. They are small fish of excellent flavor, and are put upon the market fresh, salted and smoked, and packed in oil.

Shad is a salt water fish of high nutritive value and delicate flavor, which is found along the Atlantic coast from Florida to the St. Lawrence. It has also been introduced into the rivers of the Pacific slope and promises to thrive there. Shad run up the rivers from the sea for spawning purposes every spring, and after their return disappear in the deeper parts of the ocean. They produce large quantities of eggs—as many as 150,000 in some specimens—and the shad roe is considered a great delicacy, always commanding a good price. From an economic point of view the shad stands third in production in the United States, being only exceeded by the salmon and the cod.

The **red snapper** is abundant in the deep waters of the Gulf of Mexico, and off the west coast of Florida. It weighs from 10 to 30

[1] National Geog. Mag., Vol. 23, p. 498.

pounds and the flesh, which is high in protein and of excellent flavor, is much prized as a food. On account of the fact that this fish bears shipping extremely well, it is often sold in the northern markets.

The **sturgeon** is a large fish frequenting the northern sea and streams. It is valuable for food and more especially for its eggs, which are used for making **caviar.**

Trout is one of the most important game fishes and belongs to the same family as the Atlantic salmon. There are quite a large number of species which differ slightly in appearance and quality found in the streams in different parts of the country. The trout of the Great Lakes, which belongs to a different genus than the Altantic salmon, has an average weight of 15 or 20 pounds, although the fish found in the market generally weigh less. The flesh of the brook trout contains 19 per cent. of protein and only 2 per cent. of fat, while that of the lake trout approaches in composition the Pacific salmon and contains about 18 per cent. of protein and 11 per cent. of fat.

The **whitefish** is one of the most abundant fishes of the Great Lakes, and a valuable food fish. They are caught in spawning time in the shallow waters, and retreat to the deeper waters in the winter. They contain about 22 per cent. of protein, and 6 per cent. of fat—a good proportion for dietetic purposes. The weight of the fish is from 2 to 6 pounds.

PRESERVATION OF FISH

Fish deteriorate very rapidly after they are taken from the water, and are always more appetizing if they can be cooked and eaten almost immediately after they are caught. As this is so often impossible, various methods have been devised for preserving this valuable food. The most important of these are freezing, dry-salting, drying, preserving in brine, smoking, canning either plain or in oil.

In European countries fish after they are caught are not allowed to die from suffocation, but are kept in tanks of water until they are sold and then slaughtered for immediate use. This is a much better method of handling them than that in common use in the United States. The general method with us is to keep the fish on ice until sold. When fish are put in cold storage they are frozen solid and kept in this condition for a long time. It is however still an open question as to whether fish and similar perishable animal products do not really deteriorate in quality when kept in cold storage for more than a short period. The purchaser is also entitled to know whether he is getting cold storage fish or that which has simply been kept on ice for a few days.

Recent observations[1] have shown that when meat is stored at a temperature of 32° F. the activity of microörganisms is diminished, but the activity of ferments normally present in meat still continues. While therefore meat ripens in storage, it does not decay. With regard to fish however the conclusion was reached that although a temperature of 32° F. checks the action of microörganisms and prevents putrefaction, the enzymes normally present in the flesh of fish act prejudicially and produce bodies of unpleasant flavor, so that although the fish has not decayed it becomes unpalatable.

In Norway the codfish is often simply sun-dried, by exposing it upon poles for several months. A common method of treatment in the United States and abroad, and one which produces an extremely palatable product, is by first soaking in brine and then smoke-drying. More recently a quick-curing method has been introduced in which by the use of borax and brine it is possible to turn out the finished product more rapidly.

In the ordinary process of curing cod as used in the United States,[2] the fish, either salt or fresh as soon as brought in by the fishermen are packed in hogsheads with salt and allowed to stand from eight days to three weeks. They are then taken out and washed and piled and these stacks are repiled several times so that

[1] Foods, Origin, Composition and Manufacture, Tibbles, p. 198.
[2] U. S. Dept. Agri. Bur. Chem., Bull. No. 133.

the weight of the fish above may press out the water that is in the fish at the bottom of the pile. The fish are then dried on "flakes" or latticed racks in the open air, or sometimes by artificial heat in the factories. The cod are then skinned and packed in various ways for the market.

"*Boned fish*," "shredded" and "desiccated" fish are also articles of commerce. The dried and salted codfish contains more than 50 per cent. of salt, and this must be soaked out with water before the fish is prepared for the table. Mackerel, salmon, herring, and halibut are readily and commonly preserved by the method used for codfish. Almost any of the food fishes may be preserved in brine, but those most commonly found on the market preserved in this way are mackerel, anchovies, herring, salmon and Lake whitefish.

Canning Fish

The canning of fish has developed into a great industry within a few years. As fish decomposes so readily the most careful and complete sterilization is necessary in the process. In the salmon-canning establishments along the Pacific coast the process includes scaling, cleaning, beheading, washing, and placing in nets for cooking. The fish is then packed in cans, sometimes with salt, salt water, and a little alum, and thoroughly "processed," and finally sealed. *Canning in oil* is applied especially to sardines, young herring, and other small fish. In this process the fish after being cleaned are cooked and sterilized in oil, then packed in tin cans in oil, sealed and frequently again sterilized. The oil used for the original cooking is frequently peanut oil or some other cheap oil like cotton-seed or sesamé, and while the best grades of sardines are usually canned in olive oil, other oils are often used. The chief adulterations of sardines are mislabeling as to the country where the fish were caught, use of oils other than that of the olive, and the substitution of other fish as sprats or small herring for the sardines.

Fish Products

Caviar is the preserved roe or eggs of the sturgeon, and was introduced by the Moslem tribes inhabiting Russia.[1] At first it was so expensive that it was considered a luxury to be used only by the wealthy. It is prepared in Russia, Norway, Germany and America. It is said that in some cases the roe is shipped from America to Europe, where it is repacked and shipped back to this country to be sold at an advanced price, as it bears a foreign label. The method of preparation of caviar is to rub the fresh eggs back and forth over a small-meshed wire screen of such dimensions that the eggs drop through and the membranes which enclosed them are retained. Salt is then added to the eggs and the mass is stirred with the hands. After a short time a brine is formed from the liquid drawn from the eggs, the superfluous brine is poured off, and the roe, after being drained, are put up in cans or casks and constitute the caviar of commerce. Pressed caviar and dried caviar are also upon the market. This is an extremely rich food and is used as a relish or in making sandwiches.

Isinglass or fish glue is prepared from the swimming bladder of various fish. The Russian isinglass is obtained from the sturgeon, while that from Brazil, the East Indies and America is usually obtained from other fish. It is used chiefly in fining or clarifying jellies and liquids such as wine and beer.

Fish oils are obtained by rendering any parts of the fish containing fat. Menhaden oil is made in large quantities along the Atlantic coast, but it is not an edible oil. Sardine oil is made especially in Japan, and along the Pacific coast a salmon oil is prepared which may be used for edible purposes.

SHELLFISH

Under the term shellfish are included various mollusks and crustaceans that have a shell. The nutritive ratio is not as high as

[1] Food Products of the World, Green, p. 61.

that of fish, but they are used in large quantities on account of their agreeable flavor.

Oysters are grown in shallow salt waters in numerous localities throughout the temperate zone. They thrive best about the mouths of rivers where the water is brackish. In the United States they are found most abundantly on the coast of Long Island Sound, Virginia, Mississippi, Louisiana, Texas and Washington. In England they are cultivated along the coasts bordering on the English Channel. Oysters are also found at other points along the western coast of Europe, and in China and Japan.

Since the native beds of oysters are soon exhausted, it has become necessary to introduce oyster farming. The oysters are planted in shallow waters, where they are protected for the owner by local laws. They are in their prime when from two and one-half to five years old.

Oysters may be kept in the shell for a week or two after being removed from the water, if the temperature is not over 40° to 50°, and they are occasionally wet with sea water. They may, therefore, be shipped in the shell with proper precautions, to interior points.

Composition

The average composition of oysters exclusive of liquids according to Langworthy is:

Water	88.3
Nitrogenous substances	6.1
Fat	1.4
Carbohydrates	3.3
Salts	1.9

The nitrogeneous substance is probably not all protein, but consists partly of nutrients of lower value. The carbohydrates consist mainly of glycogen from the liver, a substance which is readily digested. As the amount of solid matter is not large, about the same as milk, it is not strange that two or three dozen oysters can be eaten at a meal.

The color of oysters, especially on European coasts, is sometimes green.[1] This may be due either to the presence of sea weeds, diatoms, etc., which do not in any way injure the oysters, or it has also been found to be sometimes due to the presence of copper. The Mareuse oyster is much esteemed in Europe, and as these have a greenish color due to the pigment from infusoria or diatoms, the practice has grown up of placing ordinary oysters in salt water and feeding them on a peculiar seaweed, which would impart a green color to their gills. Worse than this is the practice of staining oysters green by the use of copper sulfate.[2] There seems to be good evidence, however, to show that the green color is sometimes due to copper which has actually been absorbed by the oysters from the water in which they live. The author has found copper equivalent to 0.09 of 1 per cent. of copper sulfate in oysters.[3] J. T. Willard,[4] who has made analyses of thirty-four samples from different points along the Atlantic Coast finds that they all contained very small quantities of copper. The amount of this metal however, is probably not large enough to be injurious.

Digestibility of Oysters

Raw oysters are very digestible, and when properly cooked they are often recommended as food for invalids. They admit of a great variety of methods of cooking, and impart to the diet a pleasing variety. They are less digestible when fried, than when cooked in any other way.

Preservation of Oysters

As already stated, oysters may be kept in the shell under proper conditions for some time. There is, however, an immense market for oysters which have been removed from the shell. These were formerly shipped in the United States to interior points in tubs in which a cake of ice was floating. Aside from the fact that

[1] U. S. Dept. Agri. Bur. Chem. Bull. No. 136, p. 29.
[2] Foods, Origin, Manufacture and Composition, Tibble.
[3] Bull. Kas. State Bd. Health, 1907, p. 36.
[4] Bull. Kas. State Bd. Health, 1908, p. 4.

this method, with its frequent "icing" en route is unsanitary, the oysters under these conditions absorb a large amount of water. This is due to *osmosis* the soluble salts of the oyster diffusing into the water, and the water entering and puffing up or "fattening" the oyster and impairing its flavor. To avoid these conditions many of the states[1] have passed laws requiring that all oysters shipped into the state shall be sent in vessels surrounded by ice, and not with the ice in contact with the oysters. They have furthermore made regulations[2] that the oysters as sold must contain at least 10 per cent. of solid matter. This has greatly improved the quality of shipped oysters. The oysters are sometimes sealed in tin cans, which are shipped in vessels surrounded by ice. Small oysters under the name of "coves" are put up in tin cans and sterilized, for use at inaccessible interior points.

Some favorite varieties of oysters are named from the locality whence they are obtained as "Blue Points" from Long Island, "Rockway" from another Long Island locality and "Shrewsburg" from the New Jersey coast and "Lynhaven Bays," from near Norfolk, Va.

Oysters are often fattened in beds near the effluent of sewers and typhoid fever has resulted from the eating of these oysters which have not been cooked. There is undisputed evidence that shellfish become contaminated when placed in sewage-polluted waters, and the results of many investigations[1] show that these shellfish have been responsible for the production of typhoid fever and other intestinal diseases. The most noteworthy cases appear where oysters have been "floated" in sewage polluted waters, in the vicinity of large cities. Oyster beds should be protected in every way from all sources of contamination, and the water should be proven to be pure by repeated examinations.

CLAMS

The clam as a food is nearly as important as the oyster, but it is more commonly used along the seashore than at a distance

[1] Stiles, U. S. Dept. Agri. Bur. Chem. Bull. Nos. 136, 156.
[2] Reg. Kas. St. Bd. Health, May 1911.

from the sea. There are two principal varieties: the long or soft-shell clam of the New England coast, and the thick-shelled round clam which is also called the "quahog." Clams are more extensively consumed in the United States during the warm summer months when the oyster is considered out of season.

In composition clams do not differ much from oysters. They contain from 6 to 8 per cent. of protein, 1 per cent. of fat, and from 2 to 4 per cent. of carbohydrates. Clams may be eaten raw, cooked, or in "chowder," but they are probably not as readily digested as oysters, because of the toughness of part of the body.

MUSSELS

Mussels are found both in salt and in fresh water. In England and France they are more generally used than in America. The flesh of the salt water mussel is of a yellow color, and somewhat tough when cooked. The fresh water mussels are gathered in the United States for the pearls which they often furnish.

SCALLOPS

Scallops, shellfish somewhat resembling oysters, are more in favor in America than in Europe, and are obtained along the New England coast by the use of dredging boats. From September to the first of March, they are considered "in season." The muscle or hard part, used for opening and closing the shell is the part of the mollusk that is eaten.

SNAILS

Snails, especially the escargot, are much used as food in France, and Austria where they are cultivated in the vineyards in "snail nurseries." These snails are vegetable feeders, and are soft and digestible when raw, but become somewhat tough by cooking. Not less than 80 million snails are sold yearly in the *Halles Centrale*, the great market of Paris.[1]

[1] The Grocer's Encyclopedia, p. 569.

LOBSTERS

Lobsters are abundant in the temperate zone along the European and American coast. The lobster although a salt water crustacean is quite similar to the common crawfish of the fresh water streams. The natural color of the lobster is dark green to black, but after boiling, it becomes red. The pinkish meat which has a sweet, delicate flavor is found mostly in the so-called tail and in the claws. This meat amounts to about 50 per cent. of the entire body. The flesh contains 11.63 per cent. of protein, 1.82 per cent. of fat and 0.62 per cent. of glycogen.[1] This flesh is rather indigestible on account of the coarseness of the fibers. The canning of lobsters is an important industry in Nova Scotia, Newfoundland, and along the coast of Maine. The so-called lobsters used as food on the Pacific coast are large crawfish and contain less edible matter than the true lobster.

CRABS

The flesh of the crab, both the "hard shell" and "soft shell" is highly prized especially in the middle and southern Atlantic States. The "soft shell" crabs are those which are caught just after shedding the old hard shell. The edible portion yields 23 per cent. of solid matter, which is similar in composition to the flesh of the lobster. Japanese crab meat (canned) is a common food on the market.

SHRIMPS—PRAWNS—CARAMOTES

These are all highly valued food products in some localities. They are found along the coast, in Great Britain, the Continent and in the United States. Large quantities of shrimps are canned in the southern states for the market.

[1] Foods and Their Adulteration, Wiley. p. 155.

MISCELLANEOUS ANIMAL FOODS

Turtles inhabiting both fresh and salt water, are important foods. The green turtle, which sometimes weighs several hundred pounds, is used chiefly in making soups which are greatly valued for their flavor. Turtle meat contains about 20 per cent. of protein and a small amount of fat. It is generally considered as a luxury, and is rather indigestible. The flesh is cut into slices and sun-dried for preservation. The **terrapin,** a salt-marsh tortoise, is found along the North Atlantic coast. The diamond-back, and the red-bellied terrapin is in common use for edible purposes. The flesh is highly esteemed for its digestibility, and agreeable flavor. On account of the demand for terrapin, there is danger that it will be exterminated in the eastern United States, and it is already so expensive as to be classed as a luxury. The effort to raise terrapin artificially has not been wholly successful. **Frogs, legs** are a standard food in the markets of continental Europe at certain seasons of the year and are gradually being utilized in the United States. They are in the best condition in the autumn and winter. The flesh, which has an extremely delicate flavor, tastes somewhat like that of chicken, and is easily digested.

CHAPTER XVI

MILK AND DAIRY PRODUCTS

Milk, since it contains all the substances necessary to sustain the life of the young animal, has always been regarded as an ideal food, and in addition to woman's milk, the natural food of infants, the milk of the cow, goat, ass, ewe, mare, camel and reindeer have been used from the earliest times as human food. The foods manufactured from milk, including butter, cheese in almost endless variety, koumiss and other fermented beverages, have also been used by different peoples from the remote ages of the past. Butter was used by the Hindus as early as 2000 B.C. both as food and in their religious ceremonies, and it is mentioned by the early Hebrew, Greek and Roman writers. It is however a product of the temperate zones rather than the torrid, as it melts so readily in warm weather.

COW'S MILK

Considering for the present cow's milk only, it is well known that the quality varies within wide limits dependent on the breed, age, condition, stage of lactation, and food of the animal, and the season of the year. If examined with the microscope, milk will be seen to contain numerous fat globules of a pearly luster, and about 0.005 millimeters in diameter. It is the presence of these globules that give to milk its yellow color, so that we are accustomed to judge something of the quality of the milk by its color.

The "reaction" of human milk and that of herbivorous animals when freshly drawn is slightly alkaline, while that of carnivorous mammals is as a rule slightly acid. In the case of cow's milk the reaction may appear to be amphoteric, that is, it gives the acid of the alkaline reaction according as different indicators are used.[1] The specific gravity of milk varies from 1.029 to 1.035 at 60° F. This is not considered as valuable an index of the quality of milk as formerly.

It is practically impossible to obtain clean milk from cows that are kept in filthy surroundings. To obtain milk of excellent quality the cows should be housed in light, clean, warm, well-ventilated stables. In the best dairy practice the floors are of concrete, the windows are screened to keep out flies, and an abundance of good water is supplied. The udder of the cow is carefully brushed and cleaned before milking. The attendants are free from infectious disease, wear clean clothes when milking, and avoid noise and confusion in handling the cows.[2] The custom that has recently been adopted in the best dairies for marketing milk in closed bottles is an advance in sanitation. In Europe it is sold from tin or brass cans. (Fig. 59.)

FIG. 59.—The Flemish milk seller.

[1] Bordas, Eighth Int. Cong. Ap. Chem., Vol. 18, p. 67.
[2] U. S. Dept. of Agri. Bur. An. Ind. Circ., 142.

As milk affords an ideal medium for the growth of bacteria, it is of importance that the milk room, where the milk is stored, be clean and cool. The milk should be cooled to below 50° F. as soon as possible after it is drawn, and kept cold until delivered to the customer.

Tuberculous Milk

The cows should be examined from time to time to determine whether they are afflicted with tuberculosis, and any suspected animal should be immediately isolated from the rest of the herd, and its milk rejected.

Says Dr. F. H. Billings: "Tubercle bacilli in milk are generally of bovine origin. If a diary cow is suffering with tuberculosis there is a chance of the milk becoming contaminated with the bovine type to which children are particularly susceptible. The bacilli find entrance through lesions in the udder and through particles of excrement that fall into the pail in the process of milking. It has been shown that cows afflicted with the disease may pass virulent bacilli with their feces, and it is probable that contamination from this source is of greater frequency than it is from diseased udders. Dependence on ordinary clinical symptoms for detecting tuberculosis in dairy herds should not be considered, as animals may give every appearance of being healthy and yet may be scattering virulent organisms. Reliance should be placed rather on the "tuberculin" test, and the removal from the herd of those animals which react with it."

"The occurrence of bacilli of human origin in milk is sometimes traceable to careless handling by persons afflicted with consumption. Though this source of danger doubtless plays a less important rôle than the other, it is real, and great care should be exercised in excluding diseased persons from handling milk that is used by others."

"While man is the main source of human infection (with tuberculosis), the proportion due to material of bovine origin is sufficiently large to make it very important that proper steps be taken to prevent this source of human disease. It must be conceded that while infected meat cannot be altogether excluded as a source of human tuberculosis, in nearly all the cases of human infection from bovine sources, the vehicle is milk or milk products."[1]

In many parts of the country, regular inspections of the dairies are made by competent veterinarians, under the direction of the state or the municipal health authorities.

Abnormal Milk

The secretion from the udders of cows and other mammals for some days after the birth of the young acts as a purgative and has a pungent taste. It is called "colostrum," and is not considered fit for human food. It contains less water and sugar than normal milk and much more albumin and ash. The amount of fat is extremely variable and it contains small organized bodies which are generally regarded as the débris of the cell structure of the gland. The milk secreted for some weeks before the calf is born is also usually rejected.

Composition of Milk

The composition of the milk of different animals is as follows:[2]

	Spec. Grav.	Water	Casein	Albumun	Total proteins	Fat	Milk sugar	Ash
Cow's	1.0315	87.17	3.02	0.53	3.55	3.64	4.88	0.71
Human	1.0290	87.41	1.03	1.26	2.29	3.78	6.21	0.31
Goat's	1.0305	85.71	3.20	1.09	4.29	4.78	4.46	0.76
Sheep's	1.0341	80.81	4.97	1.55	6.52	6.86	4.91	0.89
Mare's	1.0347	90.78	1.24	0.75	1.99	1.21	5.67	0.35
Ass's	1.0360	89.64	0.67	1.55	2.22	1.64	5.99	0.51

It is evident that milk, although a liquid, contains less water than some vegetables and fruits, for instance asparagus, which

[1] Milk and the Public Health, Savage, p. 321.
[2] König.

contains 94 per cent. of water; tomatoes 94.3 per cent.; strawberries 90.4 per cent.; and watermelon 92.4 per cent.

In milk the soluble substances are milk sugar (lactose), soluble albumin and mineral salts especially phosphates of calcium, etc., while the material in less complete solution is a part of the casein, and the fat globules held in suspension in the serum. Milk sugar is an excellent food substance and may be obtained as a by-product from whey in the manufacture of cheese. (See p. 426.)

Changes in Milk

The first change that takes place in the milk on standing is the separation of the fat as cream, which rises more readily when the milk is kept at a low temperature. The second change that the milk undergoes is souring which is accelerated by warm weather and by storing the milk in unclean vessels, or in filthy surroundings. This change is brought about by the bacterium acidi lacti and other bacteria of the lactic acid group, which aid in the formation of lactic acid ($C_3H_6O_3$) from the milk sugar (lactose) $C_{12}H_{22}O_{11}+H_2O$ present. The casein is at the same time changed from a soluble to an insoluble condition. The peculiar properties of milk are taken advantage of in the making of butter from the fat and cheese from the casein.

Digestion of Milk

On account of its unique composition and from the physical condition in which the nutrients occur in milk, this is one of the most completely digested of all foods, for 95 per cent. of the proteins, and 97 per cent. of the carbohydrates are absorbed, and utilized. If milk is taken in a mixed ration, which has been found to be the best method of administering most foods, practically all of the nutrients contained are utilized by the body. It is probably on account of the digestive action of certain enzymes or ferments contained in milk, that this liquid assists in the digestion of other foods with which it may be combined.[1] There are some persons, however, who do not readily digest milk, and they should refrain as much as possible from using it.

Certified Milk

This is a product which has been drawn from "tested" cows, and handled and marketed in a particular manner as prescribed by the proper authorities of the community where it is sold. In a few states only have laws been passed *defining* "certified milk," and except in these states the term "certified," as ordinarily used, means nothing, as it may be certified by interested parties. The regulations of the Milk Commission of the Medical Society of the county of New York require that there shall be less than 30,000 germs of all kinds per cubic centimeter in certified milk. It must contain on the average 4 per cent. of butter fat, and must be sold on the day in which it reaches New York City. Those dealers who furnish milk that is in every way up to the standard are entitled to use caps on their jars stamped by the city as certified by the Milk Commission. It is the duty of the official inspector to see that there are no tuberculous or diseased cows in the herd, that the stables are clean, that the milk is drawn in sanitary surroundings, by clean employees, and that it is, as far as possible, free from bacteria. Certified milk is often found containing only 8000 bacteria per cubic centimeter, while an ordinary market milk may contain as many as 50,000 or more. As milk has proved almost indispensable and for general purposes, as a food for infants and invalids many experiments have been directed toward keeping it sweet as long as possible after it is drawn.

Pasteurized Milk

The *boiling of milk*[2] produces the partial fixation of the calcium salts, probably precipitated as tri-calcium phosphate, and the

[1] Minn. Ex. Sta. Bull. No. 86 (L.U.).
[2] Morse, J. A. M. A. Vol. 60, p. 876.

precipitation of magnesium salts. About one-third of the citric acid is precipitated as tri-calcium citrate, and the soluble albumins are entirely precipitated.

Pasteurized milk is a product which has been heated to 157° F. for ten minutes or longer, whereby the activity of the bacteria is very much diminished and many of the non-spore-bearing bacteria are killed. Milk from an unknown source should always be pasteurized before being given to young children. Two processes are in common use. In the "holder" process which is most in favor the milk is held at 145° F. for thirty minutes. In the "flash" process the milk is gradually heated to 160° F., held at this temperature from thirty seconds to one minute and then quickly cooled. Milk may be conveniently pasteurized in the home[1] by setting the bottles in which the milk is delivered into a tin pail upon a false bottom of wooden slats or an inverted pie tin in which some holes have been punched, filling the pail with water, nearly to the level of the milk, and placing it on the stove or over a gas flame. Puncture the pasteboard cap of one of the bottles and insert a thermometer. An instrument provided with a scale etched on the glass is the best form to use. Heat the milk until the mercury stands above 150° F., but below 155° F., then remove from the stove, and allow to stand from twenty to thirty minutes, after replacing the punctured cap with a new one. Take the bottles out of the pail, cool quickly and keep in a cool place, or better, replace the warm water in the pail with cold until the milk is thoroughly cooled, and keep in a cool place. Pastuerization,[2] when properly performed, affords protection from pathogenic organisms, it causes a reduction in infantile death rate due to intestinal diseases and increases the keeping quality of the milk. Notwithstanding all these advantages numerous objections have been raised to the process.

Milk is **"sterilized"** when heated to a temperature between 180° F. and boiling. By this process, however, some of the casein is coagulated and the milk is not as wholesome a food as if merely pasteurized.

[1] U. S. Dept. Agri. Farmers' Bull. No. 413.
[2] U. S. Dept. Agri. Bur. Animal Ind. Circ. 184.

Evaporated Milk

Several products under the name of "*evaporated milk*," "*condensed milk*" "*preserved milk*" and "*evaporated cream*" are upon the market. Although numerous patents were granted, earlier yet the first commercially successful plant for making condensed milk in the United States, was erected by Gail Borden in 1856 at Wolcottville, Conn. At the present time there are more than 300 milk-condensing plants.[1] The value of the condensed milk made in a single year (1909) was over $33,000,000. An American, Chas. Page, introduced the process into Switzerland, and was the first to build a factory there. Milk preserved in this way is an extremely convenient addition to the diet as in the army, on shipboard, and for the traveler, where fresh milk is not obtainable. It is concentrated and canned either with or without the addition of cane sugar.

Condensed milk is most readily prepared by boiling the milk in a vacuum pan to the required density, and then sealing immediately in tin cans. In the United States, before the enforcement of the "Pure Food Laws," there were in the market many brands of "so-called" condensed "cream" or evaporated "cream" that were in reality only concentrated milk. Skim milk was often concentrated and sold as evaporated whole milk. At present the label on the can must correctly describe the contents.

A comparison of the percentage composition of the sweetened and unsweetened condensed milk is as follows.[2]

	Total solids	Water	Milk solids	Cane sugar	Milk sugar	Proteins	Fat	Ash	Fat in original milk
Normal sweetened cond. milk	74.29	25.71	32.37	41.92	11.97	8.46	10.65	1.29	4.56
Normal unsweetened cond. milk	28.16	64.24	......	2.2	9.85	8.66	8.10	1.55	3.68

[1] Year-book., U. S. Dept. Agri., 1912.
[2] Food Inspection and Analysis, Leach, p. 187.

Diluted condensed milk is sometimes used as food for infants. It is by no means a perfect food, but it has the advantage of being free from bacterial contamination, and in some circumstances is safer than raw cow's milk. This is particularly the case when traveling, or living in the city where milk that is known to be of good quality cannot be obtained.

Desiccated Milk

Special processes have recently been invented for evaporating milk to a *dry powder*. One of these consists of feeding the milk in a thin sheet on to a pair of steam-heated cylinders revolving in opposite directions, and having a surface temperature of about 212° F. (100° C). The milk is dried in about thirty seconds, and is scraped from the roll by a knife edge. By another process the milk in the form of a spray is forced into a hot air chamber while an air current drives the dry particles against a screen which arrests the solid portions and allows the air to pass on.[1]

The greatest difficulty in the manufacture of desiccated milks has always been the preparation of a product which is sufficiently dry so that it will keep in all climates and at the same time be completely soluble in water. Probably the desiccated milk which most nearly meets these conditions is that made by spraying the fresh milk into a warm, vacuum chamber where the mist is almost instantly deprived of its water and the resulting powder falls to the floor of the oven. When the proper amount of water is added to this dried milk, the mixture closely resembles ordinary milk, and is used by bakers for many purposes where milk is required. Some of the so-called milk powders or desiccated milks on the market, are evidently dried pulverized and skimmed milk. This does not as readily become rancid as the powder made from whole milk. If sold under their true names and at prices to correspond there is no objection to the use of milk powders.

[1] Year Book, Dept. Agri., 1912.

Skim Milk

Skim milk is an excellent food substance, as it is whole milk simply deprived of its fat, by hand skimming or the use of the separator. It still contains the valuable proteins, a little fat, the milk sugar, and most of the mineral salts. Skim milk should be sold under its true name and should not be used as an adulterant for whole milk.

Modified Milk

As may be seen from the analysis on page 387, human milk is not as rich in solids as cow's milk, and although it contains about the same amount of fat, there is more sugar and less protein. Over 50 per cent. of the protein in human milk is in the form of albumins, while in cow's milk only one-fifth is in that form the remainder being in a state probably less digestible. Cow's milk has also a tendency to curdle into tough masses in the human stomach, and this material is not as readily digested as a similar product when coagulated from human milk. Furthermore, the fat globules are much smaller in human milk than in cow's milk.[1] There are, therefore, many points of difference between the two kinds of milk, and in infant-feeding especially an effort is made to imitate human milk by "*modifying*" cow's milk. The ingredients usually employed for this purpose are cream, containing 16 per cent. of butter fat, skimmed milk (from the separator) milk sugar, and sometimes lime- or barley-water. These should always be mixed according to a formula prescribed by a physician, or by a competent nurse. The proportion of each ingredient to be used varies with the age of the infant. As cream is generally rich in bacteria, infants often thrive better if it is not added in preparing modified milk. In modifying milk, the general method is to bring the proteins and ash to the right proportion by dilution with water, to add lactose to increase the sugar, and finally cream to increase the per cent. of fat.

[1] Human Foods, Snyder, p. 89.

ADULTERATION

Milk is *adulterated* in various ways, usually by

1. *Addition of water.*
2. *Removal of cream with or without addition of water.*
3. *Addition of preservatives.*

In detecting the addition of water the lactometer, an instrument for determining the specific gravity of milk, which sinks to a definite point in pure milk of a specified temperature, is useful. If however, fat is removed thus raising the specific gravity, and at the same time water is added, which lowers the specific gravity, these two operations may be so combined as to produce a sample of milk that will nearly correspond in specific gravity to whole milk, although of course adulterated. Before being assured as to the purity of the sample it is necessary to determine the amount of fat and the "solids not fat."

The per cent. of fat can be obtained by the use of the "Babcock" tester, a simple instrument devised by Prof. Babcock of Wisconsin. To use this instrument, 17.6 c.c. of milk are placed in a bottle which has a long neck graduated in such a way that the numbers represent per cent. of fat. 17.5 c.c. of commercial sulfuric acid (1.82 sp. gr.) is then added to the milk and the bottle is whirled rapidly in a "centrifugal," so that the particles of butter fat which separate may be collected on the top. Sufficient hot water is added to bring the fat into the narrow neck, and the machine is again rotated for a short time. The percentage of collected fat can then be read directly. Machines of this type are in general use at all dairies and milk factories.

In order not to exclude any genuine milk, the standard of the fat content of milk which has been adopted in the different states of this country and in England is low (3.00 to 3.50 per cent.). On this account it will be readily seen that the rich milk of some cows, especially of the Guernsey and Jersey breeds, may be either lightly skimmed or may be diluted with water, and yet the milk will appear to be unadulterated, if tested only for fat by the ordinary methods. In the latter case the "solids not fat" would be decreased below the normal quantity, and so the adulteration could be readily detected. The standard for "solids not fat" in use by the U. S. Dept. of Agri. is 8.5 and the amount of "total solids required in the different states varies from eleven in Idaho to thirteen in Minnesota. In case there is a disagreement as to the amount of fat in a sample of milk, it is best to draw the milk directly from the cow, and have it tested. In this connection it should be noted, however, that the first milk drawn from the udder is not as rich in fat as the last milk or the "strippings" as it is called, and so in order to get a fair sample *all the milk* should be drawn and well mixed before being tested.

The Use of Preservatives

In order to prevent the souring of milk various chemicals have been added to it. Formerly sodium bicarbonate (baking soda) was used for this purpose as it would neutralize the lactic acid as fast as it was formed. More recently the milk has been preserved by the use of boric acid, hydrogen peroxide or formalin. The addition of any chemical of this character to preserve milk cannot be too strongly condemned. The practice is forbidden by law in most of the cities and states of the Unites States. A food that is of such importance, and is frequently the sole dependence for nourishment for infants and invalids, should be kept absolutely free from adulteration.[1]

Poisonous Milk

Although milk affords an excellent medium for the growth of germs, most of those found in milk are not injurious to the system. There are, however, certain bacteria which find their way into milk if stored in dirty, damp unsanitary surroundings, which produce extremely poisonous products. These are sometimes found in milk, cheese and ice cream and if taken into the system, produce

[1] Milk and the Public Health, Savage, p. 389.

very dangerous and sometimes fatal results. These poisons have been studied by numerous chemists, especially by Vaughn,[1] and are now known to belong to the class called ptomaines. The name *tyrotoxicon* (cheese-poison) was given to one of these most frequently found in milk.

KOUMISS AND KEPHIR

Koumiss is an alcoholic beverage made originally in Asia Minor by fermentation of mare's milk, which it has been noticed, is richer in sugar than cow's milk. This beverage contains from 1 to 2 per cent. of alcohol, and less than 1 per cent. of lactic acid, and the casein is somewhat modified during the process of fermentation.

Kephir (or Keffir) is a drink prepared especially in the Caucasus, by the fermentation of cow's milk using a fungus known as Kephir grains. It usually contains less than 1 per cent., though occasionally nearly 2 per cent. of alcohol.[2]

A double fermentation takes place during the manufacture of Koumiss and Kephir. The sugar of milk is partly converted into lactic acid by "lactic" fermentation, and in part, a "vinous" fermentation takes place similar to that which occurs in the making of wine. The lactic fermentation begins first and lasts the longest, but it is the aim of the koumiss maker to restrain the lactic fermentation as much as possible.[3] Mare's milk, although a poorer food than cow's milk, is better adapted to this double fermentation, as it is richer in sugar, and the fact that it contains less fat renders the resulting product more digestible. The casein in Koumiss is in such a form that it is more easily attacked by the digestive juices than is the casein in milk, and the carbon dioxide gas, one of the products of the fermentation stimulates the action of the stomach, while the alcohol acts as a slight stimulant so that patients who cannot assimilate whole milk often benefit by the use of this product.

[1] Vaughn-Novy, Ptomaines and Leucomaines.
[2] Douglas, The Bacillus of Long Life, p. 90.
[3] Foods and Dietetics, Hutchinson, p. 135.

In the United States and Europe an imitation koumiss is made by fermenting cow's milk with yeast at a low temperature, often after the addition of cane sugar. The beverage should be kept in the same bottles in which it is made and these should be stored with the necks down. Care should be taken to see that the corks are tied in securely, and during the first day or two it is advisable to shake occasionally.

A so-called koumiss may be made as follows: To 5 quarts of separator or skim milk add 2 quarts of water, 2 1/2 ounces of granulated sugar, 1 ounce of milk sugar, and 1 ounce of good yeast, then allow the mixture to stand for thirty-two hours at a temperature of 100° F., stirring vigorously every five or six hours. Decant into patent stoppered or pop bottles and cork securely. Store in a cellar at a temperature of 55° F., and use within six days.

Yoghoort[1] (or Jauert lactic acid bacteria) which is found in the market as a material for making a milk beverage, consists of three bacteria, viz., Bacillus Bulgaricus, which produces most of the lactic acid and works in milk up to 2 1/2 per cent. of this acid, a lactic acid streptococcus, and Bacteria lactii acid, Güntheri. Sometimes the Bacillus Bulgaricus is mixed with the Glucobacteria, in order to produce a sugar from starch in the intestines, as food for the growth of the Bacillus Bulgaricus. Skimmed milk is boiled or pasteurized, cooled and innoculated with these bacteria, and allowed to stand for some time in a warm place to facilitate their growth. It is then cooled and will keep for some time on ice. The theory has been advanced that the great age attained by some of the Bulgarian peasants is due to the continued use of sour milk products.[2] **Matzoon** is another milk preparation, introduced from Armenia. It appears to have been produced by the lactic fermentation of milk enriched with cream.[3] **Leben** is an Egyptian product made from the milk of the buffalo, camel, cow or goat.[4] **Dadhi** is a similar preparation made in India.

[1] Hügo Kühl, (Abst.) C. A., Vol. 6, p. 2797.
[2] The Prolongation of Life, Metchnikoff.
[3] Dairy Chemistry, Richmond, p. 244.
[4] Nat. Geog. Mag., Vol. 26, p. 567.

MILK PRODUCTS COMPARED

Comparing some milk products, it has been found that the fuel value[1] is as follows:

	Calories Per Pound
Whole milk	310
Skim milk	165
Buttermilk	160
Cream	865
Unsweetened cond. milk	780

As the estimation of the fuel value is the best way of determining the relative nutritive value of foods, these figures show, other things being equal, how valuable these products are as food. They serve also to emphasize the fact that skim milk and buttermilk have so much nutritive value, that they should not be ignored as valuable additions to human food.

Homogenized Milk

An apparatus known as a "homogenizer," which has the faculty of disrupting the globules of fat in milk so that the cream will not separate by merely standing, has recently come into use. It is used for mixing butter or other fats with skim milk to form a "so-called" cream, but it has been ruled by the Dept. of Agri. that the product is not entitled to be labeled cream.[2]

MILK OF VARIOUS ANIMALS

Those that have become accustomed to the milk of the cow rather than that of some other mammal, naturally prefer this milk before any other, but this is probably the result of habit and acquired taste. In many foreign countries the people who have become accustomed to the milk of other animals find it just as satisfactory as we do that of the cow. Goat's milk is in very com-

[1] U. S. Dept. Agri. Farmers' Bull. No. 363.
[2] U. S. F. I. D. No. 119.

mon use, especially in the mountainous districts of Europe. In Italy it is no unusual sight to see the milk "peddled" through the streets of the cities, by driving the goats to the door, and milking in the presence of the customer. (Fig. 60). There is quite a difference of opinion among physicians as to whether there is any

FIG. 60.—Selling goat's milk, Italy.

advantage in using goat's milk in the place of cow's milk for feeding infants.

According to recent statistics there are upward of 3,500,000 goats in Spain.[1] These are driven through the streets for milking during the early morning and afternoon hours. Only a small portion of the milk produced is made into cheese. The goat weighs from 55 to 96 pounds, and the daily average of milk given is a little over two quarts per goat. The cost of food consumed, which consists of dried alfalfa and beans, is about 9 cents a day. This milk is more commonly used in Spain than is cow's milk.

The milk of the buffalo is still used in India, and that of the Llama in South America, while camel's milk is a staple food on the

[1] Daily Consular and Trade report, No 283. 1913.

deserts of Arabia, and mare's milk on the steppes of Russia and central Asia. The milk of the sheep is used in parts of Europe in various ways, including the making of cheese, and reindeer milk is a common food in the arctic regions.

In many countries, milk forms a very important part of the food supply for adults as well as children, and much more is used per capita than can be economically raised under the special conditions of climate, altitude, feed, and environment of that locality.

CREAM

When milk is allowed to stand for some hours in a cool place, best at about 60° F., in shallow pans, the fat globules and some adhering substances rise to the surface, and give us what we call cream. This fat is in the form of an emulsion; that is, the small fat globules do not run together to make a clear oily layer because of the viscosity of the liquid, and their own surface tension. Besides the shallow pan system of raising cream, the deep setting system[1] is also in use. In this process the milk, as soon as drawn, is placed in tall cans, which are immersed in cold water or surrounded by ice. A temperature as low as 40° F. has been shown to be the most satisfactory. The cans are supplied with a glass gauge in one side so that one can see when the cream has risen, the milk can then be drawn off through a faucet at the bottom, leaving the cream in the can. It is asserted that by this system, not more than two-tenths of 1 per cent. of fat is left in the skimmed milk, while by the shallow pan system, it is difficult to obtain a skim milk that contains less than five-tenths of 1 per cent.

In addition to these two methods of gathering the cream from the milk, we have that depending upon the centrifugal "separator." The introduction of this type of machine opened a new epoch in the methods of butter-making. Since the first mechanical separator was patented many improvements have been made. The instrument consists essentially of an upright bowl turning on a perpendicular axis at a rate of from 5000 to 8000 revolutions per

[1] Milk and Its Products, Wing, p. 98.

minute. When the milk is run into the machine, the centrifugal force, acting more strongly on the heaviest parts of the milk, throws them to the periphery of the bowl, and here the skim milk is drawn off, while the lighter part of the milk (the cream) remains closer to the center and is discharged through its proper pipe. The rate of inflow can be regulated so that the apparatus will deliver cream of any desired degree of richness. A good separator will leave only one-tenth of 1 per cent. of fat in the skimmed milk. The capacity of the larger machines is from 1000 to 2000 pounds of milk per hour.

Composition of Cream

Commercial cream contains from 18 to 25 per cent. of butter fat. The standard of the A. O. A. C. is 18 per cent., but different standards have been made in the different states. It would be well if more attention was paid to the quality of cream furnished for domestic use. Its butter fat content should be just as carefully watched as that of milk. Cream obtained by the use of the separator can be made much richer than gravity cream, and will keep longer, as it does not contain so much of the entangled casein. In addition to adulterations by the use of preservatives, and the addition of milk, gelatin and calcium saccharate have been used to increase the consistency of a low-grade cream. "Whipping cream" should contain from 30 to 40 per cent. of butter fat.

ICE CREAM

The manufacture of ice cream is largely a development of the nineteenth century, especially in the United States. The first advertisement of ice cream appeared in a New York paper, June 8, 1786, but the wholesale business was not originated until after 1800. The present annual output is over 120,000,000 gallons.

According to the U. S. Standard, "ice cream is a frozen product made from cream and sugar, with or without flavoring, and contains not less than 14 per cent. of milk fat. A fruit or a nut ice cream may contain not less than 12 per cent. of milk fat." The ordinary method of freezing is to place the material in a vessel in which it can be mechanically stirred, and surround this vessel with crushed ice and salt. The temperature produced by this mixture is 0° F. which is so much below 32° F., the freezing point of water, that the interior mass is quickly congealed. In large ice cream factories, where the brine surrounding the cream is cooled by liquid ammonia as in the commercial ice plant, the process of ice-cream making is continuous, and the frozen mass is continually delivered from the machine.

Previous to the enactment of the Pure Food Act in the United States, analyses of the so-called ice cream on the market, showed that while some contained 20 per cent. of milk fat, much of it contained less than 10 per cent. and not a little was actually poorer in fat than legal milk, for it contained less than 3 per cent.

Sometimes eggs or starch are added to the milk or cream in making ice cream. This product, if not up to the standard in milk fat should be called frozen custard, and sold as such. It is quite a common custom among ice cream manufacturers to add to the cream a little gelatin, or agar-agar, or commercial casein and especially gum tragacanth. Some makers assert that this is necessary in order to make the cream "stand up" during transportation. This is quite probably the case, but it is well to remember in this connection that ice cream is sold by bulk and not by weight and the addition of these thickeners very materially increases the number of pints of ice cream which can be made from a gallon of raw cream.

If the cream used is of good quality its viscosity increases with age, and permits an increase in bulk when it is frozen. Some manufacturers always pasteurize their cream before freezing, while others prefer to make the ice cream from the raw cream.

Through a recent invention the milk or cream may be "Homogenized," that is by the use of a suitable apparatus the cream is subjected to a pressure of from 3000 to 5000 pounds per square inch and is thus made homogenous throughout. The use of this product enables the ice cream manufacturer to make cream having the body and texture of a 20 to 25 per cent. article, from a cream containing only 16 or 17 per cent. of butter fat.[1] (See p. 398.)

Ice cream is flavored by the use of extract of lemon or vanilla, and with chocolate, cocoanut, coffee, fruits, nuts and berries. Genuine fruits and berries either fresh or preserved, impart a delicious flavor to the product, but cream which is artificially colored with aniline dyes, and flavored with synthetic extracts should be avoided. Ice creams have been found on the market in which a part of the milk fat had been replaced by cheaper animal or vegetable fats. Reference has already been made (p. 396) to the occurrence of "tyrotoxicon," a ptomain poison in cream that has been stored in unsanitary surroundings.

The use of ice cream in the United States is constantly increasing. The manufacture of these products has never been so far perfected in Great Britain or on the Continent, as in the United States, nor have the people learned to use them so extensively.

BUTTER

When cream is designed for the manufacture of butter a "ripening" process is required before it is suitable for making a good quality of butter. No special precautions are required when the shallow pan or deep-setting system of raising cream are used, as these processes require considerable time and the cream has time to ripen, but with the employment of the separator, the cream must stand for several hours to become fully ripened.

Ripening Cream

For the ripening of separator cream, its temperature is reduced to at least 50° F. for a time, and the process is completed at a temperature of 60° F. to 70° F. It is during the process of ripening of the cream that the characteristic and agreeable flavors that so modify the quality of the butter[2] are developed. In

[1] Milk and Its Products, Wing, Revised Ed.
[2] Loc. cit., p. 127.

the ordinary sense, this ripening is due to the production of lactic acid through the agency of the lactic ferment. The presence of the germs that bring about this fermentation in the cream may be left to chance inoculation or they may be added to the cream. If it seems desirable to add the germs of fermentation, this may be done by adding some buttermilk or cream, or an artificial "starter" of soured skimmed milk, or some commercial lactic ferment may be used. It is important that only the desirable germs should find their way into the milk, for there are both "good" bacteria and "bad" bacteria.

The use of commercial bacterial ferments was originally practised in Sweden and Germany, and has now become quite common in first-class dairies abroad. In the United States, through the efforts of the Agricultural Experiment Stations of Connecticut, Michigan and other states, the use of improved cultures has been extended, and the amount of butter produced with the "June butter" flavor has no doubt been increased. It is still, however, true that with the best sanitary surroundings, butter of a high quality can be made without any artificial cultures.

Ripening also aids in the ease of churning, the completeness of churning, and the keeping qualities of the butter.[1] Over-ripening causes an undue separation of casein, which appears in the butter as white specks or flakes, the butter does not keep as well, and its flavor is injured.

Churning

The agitation of the cream, known as churning, causes the particles of the butter fat to unite together in masses, and they may be thus separated in the form of butter from the buttermilk which still contains the milk sugar and some casein. In early times the skins of animals were used as receptacles for milk. This led naturally to the churning of the milk in a goat or sheep skin, by rocking it on the knees, a process that is still used in the Pyre-

[1] Lcc. cit.

nees.[1] The proper temperature for churning depends on many factors, but in general is between 50° F. and 66° F., and should be as low as possible compatible with the butter "coming" in a reasonable time.

Working the Butter

After the butter is "gathered" in the churn and the buttermilk is drawn off, the butter should be washed several times with cold water, and then taken out and "worked" to remove as much of the water as possible, as the presence of this dilute buttermilk interferes with the keeping qualities of the butter. During the process of working, salt is usually incorporated in the butter, to improve the flavor and to slightly assist in its preservation. As salt is cheaper than butter, some manufacturers add it in excess. On the Continent of Europe, salt is hardly ever used, and the butter is purchased every day for immediate consumption. A person who uses unsalted butter for a time, soon ceases to notice the absence of salt in the product. Butter for immediate consumption is put up into cakes or prints by being pressed into a mold. These are of standard weights as 1/2 pound, 1 pound, etc. Considerable difficulty has been experienced in some states because the butter factories persisted in putting short weight packages on the market. They even went so far as to claim that these were not sold as standard weights, but only as "cartons" or "packages."

Packing

Butter may also be packed with salt and a little sugar[2] in a tub or crock, and kept for some time or shipped to a distant market. In some parts of Europe it is a common practice to heat butter to boiling, and keep it hot until the water has been expelled, then filter it into earthen-ware jars through cloth to remove any casein. By this process, butter made in the summer is preserved for use

[1] The Bacillus of Long Life, Douglas, p. 9.
[2] Church, Food, p. 154.

in the winter, but the flavor and texture of the butter are injured. Boric acid and borax are sometimes used, especially on the Continent to preserve butter for export.

Composition of Butter

The average composition of good butter is as follows:[1]

	Per cent.
Fat	85
Casein	1
Salt	3
Water	11

A recent bulletin[2] gives the following as the average composition of creamery butter from eight of the most important dairy states, and this fairly represents the butter on the market to-day in the United States. Average of 645 samples: fat 82.31; water 13.92; salt 2.62; curd 1.14.

Composition of Butter Fat

Butter fat consists quite largely of the ordinary glycerides (see p. 307) which contain the acids oleic, stearic and palmitic[3] but the substances which really distinguish butter from the other fats are the glycerides of a number of the volatile fatty acids, especially butyrin, caproin, caprin and caprylin. These have a characteristic taste and are soluble in water. When the butter is kept for some time, especially if much casein is present, they saponify, and yield the free fatty acids which are soluble, and the butter is said to be "rancid." Butyric acid which received its name because of its presence in butter is the most abundant of these acids (from 5 to 7 per cent.).

The existence of casein in butter is only incidental, and the smaller the amount the better the flavor and keeping qualities.

[1] Loc. cit.
[2] U. S. Dept. Agri. Bur. An. Ind. Bull. No. 149.
[3] J. A. C. Soc., Vol. 21, p. 807.

It is possible to incorporate considerable water in butter, during the working, and as water is of course much cheaper than butter fat, it has been necessary to limit the amount that may be considered legitimate. The standard of the U. S. Department of Agriculture, allows "less than 16 per cent." of water and a larger proportion is regarded as adulteration.

Coloring Butter

The butter churned from the milk of cows fed on dry rations, the usual feed in winter, is very light in color. To make this winter product look like "June" butter, and perhaps to make it more appetizing, it is a very common practice to color it. Annatto, a yellow coloring matter from the seed of the *Bixa orellana,* and occasionally aniline dyes are used for this purpose. Since the artificial color is used to make a winter butter "appear better than it really is," many condemn absolutely the practice of coloring butter.

Dietetic Value

It has been suggested that one reason why butter is so readily digested and absorbed[1] is that the melting point of the fat is low as compared with that of many of the other animal fats. Because it is one of the most easily digested of the animal foods, butter is of great value as a source of fat in the treatment of invalids. In such diseases as phthisis, diabetes and some forms of dyspepsia. patients can take as much as one-fourth of a pound a day without difficulty. Butter which has been heated, as in cooking, is, however, not so wholesome as that which is raw. It has been shown that the absorption of butter through the intestines is almost complete, so that even when large quantities are eaten less than five-tenths of 1 per cent. is wasted. In India a substance called "ghee" is prepared from the milk of the cow or buffalo, by melting butter and allowing it to cool, then pouring off the more liquid

[1] Food and Dietetics, Hutchinson, p. 131.

portion, which constitutes the "ghee." This is used in a semi-fluid condition for cooking and in the preparation of many kinds of food.

Although butter is an exceedingly valuable addition to the daily ration, it is not a cheap form in which to obtain heat and energy.

BUTTERMILK

Buttermilk differs from milk in containing very little fat. It is as rich in protein (casein) as milk, and since this is in a finely divided condition, it is quite readily digested. Buttermilk contains nearly as much milk sugar as the original milk, for the loss due to the lactic fermentation is very small. On account of the presence of the lactic acid, buttermilk is an excellent diet in the treatment of certain diseases.

MARGARINE, BUTTERINE AND "RENOVATED" BUTTER

Since butter is expensive, various cheaper substitutes have been introduced to take its place in the daily menu. As long ago as 1870 the French chemist Mége-Mouries under the patronage of Napoleon III, prepared a product called "margarine" for the use of the navy.

The butter substitutes are usually made from a refined "oleo-oil" churned with "neutral" lard, milk or sometimes a little butter.

Oleo-oil is produced in immense quantities in the big packing houses in the United States for use at home in the manufacture of "butterine" and for shipment abroad, especially to Holland. Over 138,000,000 pounds of oleo-oil were exported in 1911. In the process of manufacture the beef fat is cut in small pieces and "rendered" at the lowest practical temperature in water-jacketed kettles. (Fig. 61.) The scum is taken off from the top, and the "scraps" settle to the bottom of the kettle. The liquid fat is drawn off and allowed to become practically cold when it sets to a thin semi-solid. (Fig. 62.) This viscous fat is then wrapped in cloths and transferred to a powerful hydraulic press, where the liquid oil is separated from the solid fat by heavy pressure. (Fig. 63.) The solid position known in the trade as "oleo-stearine" finds many uses in the trades, particularly in the manufacture of "lard substitute."

FIG. 61.—Kettle for oleo stock.

The oleo-oil, as used in the manufacture of butter substitutes, is a clear amber-colored fluid, and when fresh is free from any disagreeable odor or taste. It consists of a mixture of olein and palmatin. (See p. 408.)

"Neutral" is made by melting leaf lard and allowing it to "grain" by standing for some time at a temperature favorable for the crystallization of the stearine in coarse grains.

In the further process of manufacture of the oleomargarine, the

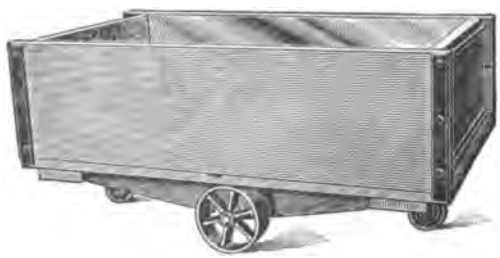

FIG. 62.—Oleo-seeding truck, in which olein separates from stearin.

oleo-oil, neutral, and usually cotton-seed, peanut or sesame oils, are mixed with the required quantities of milk, cream or butter, with or without coloring matter, and churned in the same manner as is butter. The product is then cooled by contact with ice water, drained, worked, salted and packed in much the same manner as genuine butter.

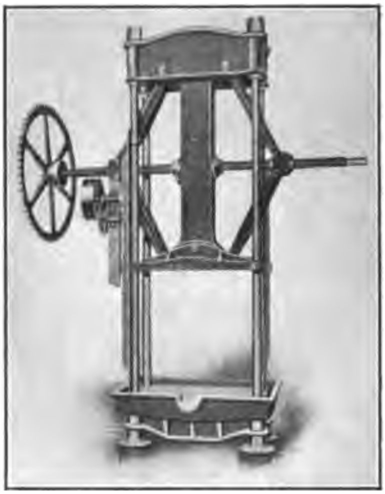

FIG. 63.—After "seeding" the stock is placed in cloths in this "knuckle-joint" press, and the oleo-oil is pressed out, leaving the hard white stearin.

The composition of commercial oleomargarine[1] is: Oleo-oil, from 40 to 45 per cent.; butter from 10 to 25 per cent.; and milk, cream, salt, etc., from 5 to 30 per cent.

Investigations (especially that of the Massachusetts State Board of Health (1887)), which were made in regard to the healthfulness of oleomargarine as compared with butter, show that there can be no objection to oleomargarine from this standpoint. It is, no doubt, not only more agreeable, but also more wholesome than much of the poor butter on the market. Says Hutchinson: "Whatever may once have been the case, margarine is now made only from pure animal fats, and the processes to which it is subjected in manufacture insure its further purification. As its flavor is equal to that of an average specimen of

[1] Food Inspection and Analysis, Leach, p. 440.

butter, and as it has the advantage of being very much cheaper, there is every reason to wish that the prejudice against it, which is still rather widespread, should quickly disappear, and that it should be welcomed as an admirable and cheap substitute for a rather expensive but necessary food." Oleomargarine should, however, be sold on its merits and not under the name of butter, and there is no reason why it should not be sold considerably cheaper than the latter.

Oleomargarine Legislation

There has been a tendency, however, to adulterate butter with oleomargarine, and to sell it for dairy butter. On this account, and in order to protect the dairy interests, much legislation in different countries has been directed against it. Sometimes this has been so severe as to be almost prohibitory. In many states of the United States, oleomargarine cannot be legally sold if colored to imitate butter, while in other states, coloring is allowable but the product must be plainly marked. The Federal law, and most state laws, require that oleomargarine be labeled in such a way that the consumer may know what he is purchasing. In 1886 the United States Congress passed a law imposing a revenue tax of one-fourth of a cent per pound on all oleomargarine, and special taxes on manufacturers and dealers. If the product is colored in imitation of butter it must pay a tax of 10 cents per pound. This law afforded a revenue of $1,259,987 last year. Peanut oil and sesamé oil, as stated above, are common constituents of margarine. In Germany the law requires that margarine shall contain 10 per cent. of the latter oil, to facilitate the detection of the fraud, if margarine is used as an adulterant of butter. In Great Britain, it is illegal for "margarine" to contain over 10 per cent. of butter, or over 16 per cent. of water. By the use of various fatty acids, especially butyric acid and its esters, and such substances as coumarin, the flavor of genuine butter is sometimes imitated in this product both in the United States and in Great

Britain.[1] Large quantities of margarine are used all over Europe, on account of the high price of butter. The people of Denmark, although themselves among the largest producers of butter, are very large consumers of margarine. The output of this country in 1911 was over 78,000,000 pounds, and with the amount imported there was a per capita consumption of 29.32 pounds. Although formerly an excess of animal fat was used, at the present time 70 per cent. of the fat is of vegetable origin.[2]

Renovated Butter

Renovated or process butter is made by melting old, rancid, unsalable butter at a temperature of about 112° F. in a tank surrounded by a water jacket and while hot, drawing off the curd and brine at the bottom and the scum at the top. Air is then blown through the mass for some time to remove the disagreeable odors and flavors as much as possible, after which it is quickly cooled. The mass is then churned with some new milk, which may contain cultures of various "good" bacteria to develop a satisfactory flavor. It is then run into ice-cold water, so as to give it a granular structure. The butter is ripened, worked and salted as usual. This product which is often sold as "factory" or "imitation creamery" butter is very much improved over the original butter from which it was made, but it is distinctly inferior to good grades of fresh butter. Several states have passed laws requiring all butter of this class to be distinctly labled as "renovated" butter. The customer should at least have an opportunity of knowing that he is not purchasing fresh butter, and pay a lower price for an inferior article. In Great Britain there is also on the market a "milk blended" butter, and a so-called renovated butter, that is a mixture of milk with various fats and oils.

CHEESE

This food has been known from the earliest ages. We read that it was in use among the Jews, Greeks and Romans, and it

[1] Foods, Their Origin, Composition and Manufacture, Tibbles, p. 350.
[2] J. S. C. Ind. Vol. 31, p 1092.

was very early used by the nomadic tribes of Asia and Africa. The fact that it is "storage food" containing much nutriment in a small space, would commend it to those without a fixed habitation.

The property of coagulation which milk possesses, would naturally be utilized by various peoples, very early in their racial history. This coagulation may be brought about naturally by the bacterium acidi lacticus and other organisms, which find in the milk, their natural medium for propagation, or it may be induced artificially by the use of an acid or of "rennet," which is a soluble ferment found in the fourth stomach of the calf. By whatever process the coagulation is produced, the casein of the milk, called the curd, which also entangles considerable fat, is precipitated, and the whey, which contains some nitrogenous matter in the form of albumin, lacto-protein and milk sugar, remains as a thin acid liquid.

Cheese Making

In the ordinary process of cheese making as used in the United States the casein is coagulated by the addition of rennet to milk, held at a temperature of about 41° C. (106° F.). Sometimes a yellow coloring matter such as annatto or an aniline dye is added to the contents of the vat. The batch while still warm is then beaten with a mechanical stirrer for the purpose of breaking into smaller pieces the chunks of curd, and then transferred to cloths, often contained in molds and the whey squeezed out in a press. When the cheese has become solid, it is removed from the mold, and stored in well-aired rooms to allow the flavor to develop under the action of bacteria. During the process of ripening, which greatly improves the flavor, there is also an increased solubility of the proteins, and the formation of a small amount of amid and aromatic compounds. The cheese during this process is daily turned and rubbed with oil. Milk must be ripened before the rennet will act, which means that a certain amount of lactic acid is desirable, and this acid also assists in the ripening of the cheese. Sometimes a "starter" of previously ripened milk or sour milk is used to hasten this ripening.

It has been asserted that the *fat test* is not a good basis upon which to purchase milk for cheese factories, as the cheese-making value depends on the amount of casein, but it has been shown[1] that a milk which is high in fat is also, as a rule, high in casein.

Use of Rennet

Rennet, the enzyme which causes the separation of the curd and whey, is exceedingly active as in cheese making only one part of commercial rennet is used with 10,000 parts of milk, yet it acts only by contact, and is not itself affected. It is said that one part of the *pure* enzyme will coagulate three million parts of milk.[2] Rennet[3] is most active at the temperature of the body (98° F.). Below 80° the action is slower, and above 100°, although the action of the rennet is temporarily increased, above 130° it is weakened and at 140° F. the activity is destroyed. The presence of soluble salts of lime renders rennet much more active, while the insoluble salts retard the action. On this account as the lactic acid is developed in the souring of the milk, the lime salts become more soluble and the activity of the rennet is increased. On the other hand, when milk is heated above 150° F., a part of the lime salts are made insoluble, and the action of the rennet is correspondingly retarded, although the milk be again cooled to the temperature at which the rennet is normally active. Calcium oxalate if added to the milk retards the action of the rennet, while calcium chloride increases the activity. A curd produced by rennet is more suitable for the manufacture of cheese than that produced by the slower action of lactic acid in the ordinary souring process. The cheeses made by the latter method will be mentioned later.

[1] N. Y. Ag. Ex. Sta. Bull. 68, New Series; also Milk and Its Products, Wing, p. 169.

[2] Tibbles, p. 294.

[3] Milk and Its Products (Rev. Ed.) Wing, p. 247.

Composition of Cheese

The average fresh cheese contains about the same ratio of protein and fat as are found in milk. More than one-fourth is protein and one-third is fat.[1] For purposes of comparison the following table gives the composition of some of the more common varieties of cheese:

	Water	Casein	Fat	Sugar	Ash
Cheddar	34.38	26.38	32.71	2.95	3.58
Cheshire	32.59	32.51	26.06	4.53	4.31
Stilton	30.35	28.85	35.39	1.59	3.83
Brie	50.35	17.18	25.12	1.94	5.41
Neufchâtel	44.47	14.60	33.70	4.24	2.99
Roquefort	31.20	27.63	33.16	2.00	6.01
Edam	36.38	24.06	30.26	4.60	4.90
Swiss	35.80	24.44	37.40	....	2.36
Full cream (average)	38.60	25.35	30.25	2.03	4.07

The cheeses, omitting a few of less importance, are divided by Tibbles,[2] into the following classes:

I. Soft cheeses:

(a) English, cottage, cream and some local varieties.

(b) Foreign, Bondon, Brie, Camembert, Limburger, Neufchâtel, Pont l'Evêque, Gervais, Strachino.

II. Hard cheeses:

(a) English:

1. Stilton type.
2. Cheddar type.

(b) Foreign: American Cheddar, Gouda, Gruyère, Emmenthaler, Edam, Gorgonzola, Parmesan, Roquefort, Sap Sago, Cacio-Cavallo, Port du Salut. (Fig. 64.)

[1] "Cheese and Its Economical Use in the Diet," Langworthy, U. S. Dept. Agri.

[2] Loc. cit.

I. Soft Cheese

Cottage cheese, or "green" cheese consists of the curdled milk precipitated by rennet, or by natural coagulation during the production of lactic acid. The batch is heated from 85° F. to 125° F. and is put into a linen bag, the whey drained off, and the remaining curd salted, pressed and kneaded by the hand and sold

FIG. 64.—Varieties of European cheese. (By permission U. S. Dept. Agric.)

for immediate use. At first it has only a slightly acid taste, but after a time ripening begins by bacterial action, and the product is changed in taste and is by many considered much improved in flavor. As it gets older, molds of different colors cover the surface of the cheese cakes. The freshly made cheese is also known as Schmierkase in Germany, and Schabrziger in Switzerland. The name "bony clabber" is in the United States and Scotland applied to the coagulated or "lopperd" milk, which has thoroughly soured but has not had the whey separated. The product may be used either as a beverage or a food.

Cream cheese is made either from cream only, from equal parts of cream and milk, coagulated fresh milk mixed with cream, or from a mixture of one part of cream with 6.4 parts of milk. It is in general similar to Neufchâtel, although richer in butter fat. The curd is coagulated by the use of rennet, and the mass is heated, usually to 84° F. When it has fully coagulated, the whey is drained off, and the curd is salted and packed into cakes, wrapped in impervious paper and put directly on the market without curing.

Camembert is a soft, fresh cheese usually 6 or 7 inches in diameter and 1 to 2 inches thick. The ripened cheese is covered with a reddish-brown mold and the interior is a soft buttery mass. The first cheese of this kind was made in 1791 by Marie Fontaine at Camembert, France. The temperature best adapted for its manufacture is that of central France from March to September. It is usually made from whole milk, although occasionally a part of the fat is removed. In the process of making,[1] the morning and evening milk is mixed, and heated nearly to the temperature at which it comes from the cow, rennet is added, the mixture is stirred for two or three minutes, and then covered and allowed to stand for five or six hours. The curd is dipped from the pan into cylindrical metal molds, so arranged that the whey can drain off. After it has drained for two days, the mold is turned over, the cheese is sprinkled with salt and allowed to drain for another day. At the expiration of this time the cheese is taken from the mold, and placed in the drying room on racks covered with straw. Good ventilation is necessary and the room is completely screened from sunlight, dust and insects. Several varieties of molds and bacteria develop during the ripening process.[2] The presence of a reddish mold on the surface is usually associated with excellence of flavor and texture. The imported cheese retails for about 60 cents per pound in the United States.

Brie, also a French cheese, is quite similar to Camembert, and has also a strong odor almost suggesting decomposition.

[1] Foods and Their Adulteration, Wiley.
[2] U. S. Dept. Agri. Bur. An. Ind. No. 115., Bull. No. 150, Bull. No. 82.

The cheese is ripened at a temperature of from 62° F. to 65° F. until the blue mold is abundant on the surface. In the process of ripening the casein is broken down and a soft creamy mass is formed in the interior. It is found in the market in flat circular masses about an inch in thickness, and from 12 to 16 inches in diameter.

Limburger cheese originated in Belgium, and is a common product in Germany. It may be made from whole or skimmed milk, which is coagulated with rennet at a temperature from 92° F. to 100° F. The curd is drained in perforated rectangular molds, is salted several times and is pressed slightly between boards. As the ripening, which requires from four to six weeks, is carried on at 60° F. in a very moist cellar, is closely related to putrefaction, this cheese has a very disagreeable odor. Most of the limburger used in the United States is now made in New York and Wisconsin.

Neufchâtel cheese was originally prepared in Switzerland, and is made by nearly the same method given for soft cream cheese. The curd after being slightly pressed, is put into a cylinder 2 1/2 inches in diameter and 3 inches high. After being removed from the molds the cheeses are dried on straw in a moist cool cellar, for about four weeks. They are then wrapped in tin foil and put upon the market.

Pont l'Evêque is a soft French cheese. The milk is set at a temperature of 88° F. and the cheeses are formed in squares or in oblong molds and are ripened in moist cellars at a temperature of 58° F.

Gervais, also a French cheese, is named after the original maker. It is made from a mixture of new milk and cream warmed to 65° F. and coagulated by rennet. The method of making is similar to that used for Bondon cheese.

It will be noticed that in making soft cheeses, none of them are subjected to much pressure. Some are ripened for a considerable time by the action of the bacteria and others are what might be called "present use" cheeses.

Potted or sandwich cheeses are common on the market in the

United States. They are made by mixing one part of butter or oil with five parts of cheese. These may be seasoned with mustard, curry powder, or similar flavors. Chopped pimento is often incorporated in Neufchâtel cheese.

II. Hard Cheese

The *hard* cheeses are subjected to a greater pressure than the soft, and are cured in a drier atmosphere. The ordinary American (New York) cheese for which the general method for making is given on p. 413 is of this variety.

In the **cheddar type** of cheese, the curd is heated and the cheese is submitted to considerable pressure. This process was in use in the village of Cheddar, England, more than two hundred and fifty years ago. The successive steps followed in making this cheese are:[1] setting, cutting, heating, cheddaring, grinding, salting, pressing and curing.

The cutting of the curd may be done by the use of gangs of steel knives. The matting together of the curd after the whey is drawn off is known as the cheddaring process. The curd is cut into rectangular blocks, piled several times, and when drained, cut up or "ground" and salted before being put into the press. This cheese is ripened at a temperature of 65° F. or 70° F., and the process requires from four to six weeks. If the cheese is made from unskimmed milk it is called "full cream," and if cream is removed it is "part skim," or "skim," as the case may be. The ordinary American factory cheese ("cream cheese") is of the English cheddar type. Sage cheese is a variety of cheddar flavored and mottled with bits of sage, although the color is at present produced in other ways.

In the **stilton** type the curd is neither pressed nor colored. It is ripened by the aid of the mold, *pencillium glaucum.* This cheese is made in Leicestershire, England, and adjoining counties, from whole milk, sometimes with the addition of a little cream.

[1] Milk and Its Products (Rev. Ed.), Wing, p. 251.

The milk is "set" for about an hour at 80° F. and the curd is then cut in slices and put upon cloths over a sink to drain. The corners of the cloth are gathered up and the cheese is squeezed several times, and allowed to stand until quite acid. The curd is then put into cylindrical tin molds 10 inches in diameter by 15 inches high which are perforated on the sides, and stand on a board covered with a cloth. The temperature is maintained at 60° F. and the cheeses are turned over twice a day. After ten days of this treatment, the cheeses are taken from the mold, surrounded with a linen band and taken to the drying rooms and later to the ripening rooms, where they should remain at a temperature of about 65° F. for several months. The spores of the *pencillium glaucum* have ample opportunity during this process to penetrate the cheese, and when ripe a blue mold will be seen mottling the entire mass. The mild flavor is largely produced by the action of this mold. This cheese retails at about 75 cents a pound in the United States. Other English cheeses are usually named from the locality where they are made.

Among the other foreign hard cheeses the following are of special interest:

Gouda is a cheese of the cheddar variety made especially in Friesland (Holland). The best grade is produced from whole milk, and the cheese is cured more rapidly than in making Edam. It is usually of only 10 or 12 pounds weight, has a pale red color, and is inclosed in a bladder or other covering of animal tissue.

Gruyère, emmenthaler and **schweitzer** cheese have been made for two or three hundred years in the mountainous regions of Switzerland and in parts of France. There are slight variations in the methods of making in different districts. Cheeses of this type can be distinguished by the large cavities distributed irregularly through the mass. These cavities are due to the action of certain gas-producing bacteria that work during the ripening process. The cheeses are seen in the Swiss markets, piled up like so many "cart wheels" and are often 3 to 4 feet in diameter. In making emmenthaler, after the curd is coagulated by rennet, it is broken up and heated with constant stirring at from 135° F. to 140° F. and is then put into the molds to drain. (Fig. 66.) The cheese is ripened in from eight to twelve months at a temperature of from 52° F. to 60° F.

FIG. 65.—Weigh house and market where Edam cheese is sold, at Hoorn, Holland. (Copyright by Underwood & Underwood, N. Y.)

The **Edam** cheese takes its name from a town near Amsterdam, where the manufacture of this cheese is the principal industry. Whole or partially skimmed milk is used and "set" at a temperature of 85° F. with rennet. It is left in the vat for some time or until quite acid. A peculiar slimy fermentation is induced by the use of some of the whey from a previous curd,[1] which contains

[1] Tibbles, p. 312.

the required bacteria. After the curd has been broken up it is put into cup-shaped wooden molds about 5 inches in diameter, having holes in the bottom, and here it is pressed slightly during twenty-four hours. It is salted and cured at a temperature of 68° F. by the ordinary methods, and the outside is painted a reddish color. When sold in the public markets of Holland (Fig. 65), this cheese is not fully ripened, but requires from nine to twelve months

FIG. 66.—Cooking curd for Emmenthaler cheese. (By permission U. S. Dept. Agric.)

to develop the characteristic flavor. "Pineapple" cheese is the same stock put into a net and compressed, then cured by the same methods.

Gorgonzola, an Italian cheese made especially in the north of Italy has a rich, pungent flavor, and is white, streaked with bluish veins, from the mold *penicillium glaucum,* which penetrates the mass.

Parmesan, also of Italian origin and coming from the provinces of Parma and Emelia, is another hard cheese that has excellent keeping qualities. It is made from partly skimmed milk, and colored with saffron. The best quality is said to be that which has ripened from one to two years. Parmesan when it is very hard and dry is used for the preparation of grated cheese and is sometimes sold in a grated form. It is very popular, especially in Europe, for use in soups and for seasoning macaroni.

Roquefort is a well-known cheese, usually made from the milk of sheep and goats, especially in France. In making this cheese the curd is placed in layers in perforated tin molds, where it is pressed for some time, and then taken out of the molds and sent to the drying room. Here it remains ten to twelve days, and is then taken to the caves to ripen. These caves are cut in the limestone rocks of the valleys, and are cool and well ventilated. Sometimes moldy bread is incorporated in the cheese to transmit to it the peculiar mold necessary to develop the flavor. During the ripening the cheeses are sometimes perforated by long needles to allow the germ-laden air to penetrate to the interior. The cheese-protein undergoes numerous changes in this process, so that in the ripe cheese it is soft and buttery and marbled with a grayish mold. These cheeses are small, weighing from 4 to 6 pounds.

Sap sago is a hard skim-milk cheese made in Switzerland. It contains for every 4 pounds of cheese 1 pound of the clover (Melilotus coeruleus), which imparts to the cheese a peculiar flavor and a green color.

Cacio-cavello is the typical cheese of southern Italy, especially of Calabria, and is made from the milk of sheep.

Port du salut was originally made in Normandy by the Trappist Monks. This cheese which is circular and about 1 inch thick, has a buttery consistency and a nutty flavor, somewhat like the ordinary American cheese. It is in great favor on the Continent, but not so well known in the United States.

RIPENING OF CHEESE

From what has been said of the above cheeses, it will be seen that by difference in materials, method of manufacture, temperature of making and of curing, and conditions which induce the growth of specific organisms, the great variety of cheese has been produced.

The whole process of ripening is evidently due to bacterial activity, and to the action of certain unorganized agents known as enzymes which induce chemical changes by "catalytic" action, that is by their mere presence.[1] As peculiar conditions are necessary to produce a given product it is often impossible to produce a cheese having the special characteristics that belong to that variety, outside of the district where it was originally produced, but cheeses of the "type" of camembert, neufchâtel, cheddar, or stilton may be produced in other localities.

Since bacteria play so important a part in the ripening of cheese, they are naturally abundant in the products on the market. From 500,000 to 100,000,000 bacteria per gram are usually present.

DIGESTIBILITY OF CHEESE

There is a prevailing impression that cheese is not a readily disgested food. Since it is concentrated nutriment, it cannot, of course, be eaten in large quantities, especially by persons of sedentary habits, without causing gastric disturbance. Cheese is not digested so much in the stomach as in the bowels, but it has been shown by experiment that 95 per cent. of the fat and 92 per cent. of the protein of cheese is ultimately assimilated, and that well-cured cheese is more readily digested than the so-called "green" cheese.

The question to what extent cheese can be used as a food to replace meat, eggs and similar animal substances is an important one.[2] The amount that can be used in this way depends largely on the care taken in devising proper combinations with other food products, thus bread and cheese is a good combination, as is also macaroni and cheese, or cheese fondue and toast or zwieback, but meat and cheese or eggs and cheese do not form well-balanced

[1] Foods and Their Adulteration, Wiley, p. 211.
[2] U. S. Dept. Agri. Farmers' Bull. No. 487.

rations as they contain too much protein. As a condiment at the close of a meal of other food, cheese has always been in favor, and no doubt does assist in the process of digestion by stimulating the secretion of the digestive juices. Only 3 pounds of cheese per capita is used in the United States.

A "cheese food"[1] has been recently put on the market. This is cheddar cheese made, cured, and ground so that it can be mixed with the whey which has meanwhile been concentrated to a thick sirup. This mass is pressed into cakes, and will keep for a considerable time.

ADULTERATION OF CHEESE

In addition to the fraud of selling one kind of cheese for another, the selling of "filled" cheese for genuine is the most common deception. Filled cheese is defined in the United States law, which was passed in 1896, as "all substances made of milk or skimmed milk with the admixture of butter, animal oils or fats, vegetable or any other oils or compounds foreign to such milk, and made in the imitation or semblance of cheese." This cheese is taxed 1 cent. per pound, and when imported must pay a duty of 8 cents a pound.

Filled cheese has been made extensively in some of the large dairy states, by bringing into a disintegrator, lard and skimmed milk, both previously heated to 140° F. in steam-jacketed tanks. The disintegrator contains a cylinder which revolves rapidly under such conditions as to emulsify the milk and the lard. The proportions used are two to three parts of milk to one part of lard. A measured quantity of this emulsion is then added to skim milk and buttermilk, in the manufacture of the cheese. The process amounts to the substitution of lard for butter fat in the cheese, and consequently a cheaper product is produced.[2]

Of the cheeses made in the United States, at least three-fourths are ordinary American cheese, while among other varieties are the

[1] Milk and Its Products, Wing, p. 233.
[2] Industrial Organic Chemistry, Sadlter, p. 288.

"types" of foreign brands, such as neutfchâtel, cheddar and stilton. New York and Wisconsin together produce three-fourths of the entire output of the country. The latest census figures (1909) show that not less than 320, 532, 000 pounds of cheese is made yearly in the United States. Canada exported, in 1910, over 186,000,000 pounds of cheese, while of the European countries, the Netherlands exported 122,000,000 pounds, and Switzerland 69,000,000 pounds.

DAIRY BY-PRODUCTS

Milk Sugar

There are some important by-products of the dairy to which no reference has thus far been made. Among these is **milk sugar** ($C_{12}H_{22}O_{11}H_2O$) which is obtained from the whey after the separation of the curd. It is made by allowing the whey to stand until the cream rises to the surface. It is then heated, and the cream and some protein skimmed off. The whey is neutralized with lime, and a little alum added, which precipitates a further amount of protein. The whey is boiled down in a vacuum pan, and the sugar allowed to crystallize out on sticks or strings. It is purified by crystallizing from water, or precipitating with alcohol.[1] Recently several improved methods have been devised for making this sugar, and its use is being extended.

This is a valuable dietary substance. It is used for medicinal purposes in making tablets, in the preparation of infant's and invalid's food and in the making of "modified" milk. One reason why it has found so much favor is because it is not fermented by ordinary yeast (*saccharomyces cerevisiæ*) as are most sugars. It is, however, fermented by special yeasts which contain "lactase," an enzyme which causes the hydrolysis of the milk sugar into galactose and dextrose, both of which sugars are fermentable by ordinary yeast. Milk sugar is usually sold as a white crystalline

[1] Dairy Chemistry, Richmond, p. 318.

powder which has only a moderately sweet taste. Because of this characteristic lack of sweetness it is sometimes known as "sand sugar."

Use of Casein

There are several food products upon the market which are made from the soluble alkali salts of *casein*. Some of these have milk sugar, and butter fat added to increase their nutritive qualities. These preparations are known by such names as "lactarine," "nutrose" and "sanatogen."

Casein, besides being a food, is coming into quite general use as sizing for paper, for making a glue for wood work and card board[1] and for making paper flasks, bags, and milk bottles waterproof. This is done by impregnating with casein solution and exposing to formaldehyde vapors. Casein is also used in the manufacture of wall paper, for enameling paper, for making a paint and for plastic masses. It is used in making "glalith," a substance which takes the place of celluloid, and in making an imitation leather.

In France the glalith industry was started in 1904. The method of making is to mold and compress the casein in the presence of formaldehyde. The product is translucent, may be readily colored, and is rendered malleable by heating at 150° F. in an oil bath, so that it can be molded into any desired shapes. The solution from which the casein is separated, since it contains milk sugar, is valuable for fattening hogs.

STATISTICS AND ECONOMICS

In the United States the dairy industry has increased rapidly during the last fifty years. The average yield of milk per cow has increased nearly 100 per cent. and the total production of butter has increased nearly four times. The great change in production

[1] Industrial Chemistry (Tague) Rogers and Aubert, p. 831.

is largely due to the introduction of the factory system including skimming stations, butter factories and cheese factories throughout the country. These are especially abundant in New York, Wisconsin, Iowa, Ohio, Pennsylvania, Illinois, Vermont, Minnesota, Michigan and Kansas. Under factory conditions better butter and cheese can be made than on the farm, as the conditions of temperature, cleanliness, storage, etc., can be so much more readily controlled. Dairy legislation in the United States has also served to foster this industry and to protect the manufacturers of the best grades of dairy product. According to the United States census report 1,700,000,000 pounds of butter was produced in 1909.

The chief dairy countries of Europe are Denmark, Holland and Switzerland. As an illustration of the great demand that has grown up in this country for foreign cheeses, it may be stated that 48,928,857 pounds were imported from Europe in 1912.

CHAPTER XVII

EGGS AND EGG PRODUCTS

As a convenient and concentrated form of nourishment, the eggs of various birds have been highly esteemed from the earliest times. They are similar to meat in containing proteins and fat, and also furnish an abundance of mineral matter, especially phosphates, which are so important in building up the body.

The hen's egg, which is, of course, the most important egg on the market, has an average weight of 60 grams (2 ounces), and of this the shell weighs 6 grams, the white 36 grams, and the yolk 18 grams. A duck's egg has an average weight of 70 grams and the egg of a goose usually weighs 190 grams. The shell consists mainly of calcium carbonate (89 to 97 per cent.) and is very porous. Inside the shell is a delicate membrane which incloses the egg like a sack.

Besides the eggs of the fowls mentioned, the eggs of wild birds are used[1] in some countries. Plover eggs are considered a delicacy in England and Germany. The eggs of sea gulls, terns and herons have been extensively collected and used as food along the South Atlantic coast of the United States, and those of gulls and murres, on the Farallone Islands off the coast of California. As there is danger of exterminating sea birds by destroying their eggs, legislation has been enacted in many states to prevent this use of sea bird's eggs. In the tropical sections of America turtle eggs are prized as food, and the eggs of the terrapin along the Atlantic coast. The eggs of fish, especially shad roe, and the eggs of the sturgeon preserved with salt, and known as caviar, are considered a great delicacy in many countries. (See p. 377.)

Many experiments have been made to increase the egg-produc-

[1] U. S. Dept. Agri. Farmers' Bull. No. 128.

ing power of the hen, and also to breed hens that will lay more regularly throughout the year instead of so sparingly in winter. A hen producing more than 200 eggs a year is considered of more than average value. Although in most countries eggs are still sold by the dozen, as they differ so much in size a much fairer method would be to sell by the pound or kilo.

Fig. 67.—The "Egg Seller," from ptg. by Bloemaert in the Rijks Museum, Amsterdam.

The fertile egg not only contains the embryo of the young chick, but it is also a storehouse for the food that it will need until it has developed sufficiently "to earn its living" outside the shell. As the yolk is first utilized in this growth, the embryo is in this portion of the egg. The *white* of the egg consists of a yellowish-white nearly transparent, ropy liquid, which has the property of coagulating and becoming insoluble when boiled. This coagulation begins at 134° F. Enclosed within the white and "tethered by two cords" to the membrane of the white, lies the yolk, itself inclosed in a separate membrane.

Composition

The *white* of the egg consists of albumin—about 12 per cent.—and water 85 per cent. with 2 per cent. of fat, sugar and extractives, and 1.2 per cent. of mineral matter. The albumin is partly dissolved in the water. The *yolk* which is yellowish-red in tint and nearly opaque is much richer in fat than the white, and contains about fifty-one parts of water with 15 per cent. of casein and albumin and 30 per cent. of oil, lecithin and similar compounds—all very valuable nutrients. The protein of the egg yolk is believed to consist very largely of a lecithin compound, which is a nitrogenous body allied to both fats and proteins.[1] Eggs also contain some phosphorous and sulfur compounds, and this accounts for the production of the ill-smelling gases, phosphine and hydrogen sulfide, when eggs decay. When eggs are brought in contact with silver the sulfur which they contain causes it to blacken on account of the formation of silver sulfide.

The composition of the whole egg as compared with meat is as follows:[2]

	Eggs		Moderately lean meat	
Water	73.7		73	
Protein	14.8	25.3	21	26.5
Fat	10.5		5.5	
Ash	1.0		1.0	

From this analysis it is evident that eggs form an addition to a diet rich in carbohydrates. The combination "ham and eggs,"

[1] J. Am. Chem. Soc. XXII, 1900, p. 413.
[2] Bull. 28 Office of Exp. Sta. U. S. Dept. Agri.

however, is lacking in sugar and starch, and consequently is not a well-balanced ration; but "French toast" or "eggs on toast" are much nearer to a satisfactory food.

Another comparison of various foods is as follows:[1]

	Refuse	Water	Protein	Fat	Carbohydrates	Ash	Fuel value cal. per lb.
Egg as purchased.......	11.2	65.5	11.9	9.3	....	0.9	635
Eggs, evaporated.......	......	6.4	46.9	36.0	7.1	3.6	2525
Cheese, as purchased....	......	34.2	25.9	33.7	2.4	3.8	1950
Sirloin, as purchased....	12.8	54.0	16.5	16.1	....	0.9	985
Milk....................	......	87.0	13.3	1.0	5.0	0.7	325
Wheat flour.............	......	12.0	11.4	1.0	75.1	0.5	1650
Potatoes, as purchased..	20.0	62.6	1.8	0.1	18.4	1.0	385

DIGESTION

Much work has been done by physiological chemists on the digestion of eggs, as they have always been regarded as of special value in the diet of invalids and young children. The earlier experiments, which were made, however, solely upon the digestibility of eggs *in the stomach*, seemed to show that raw eggs required less time to digest than soft-boiled eggs, and the latter less than the hard-boiled eggs. It should be remembered, however, that with many kinds of food, the process of digestion must be completed in the intestines.

Later experiments made at the Minnesota Experiment Station seem to indicate that although the time and temperature of cooking, may have an effect on the *rate* of digestion, they do not materially effect the *total* digestibility.[2] It may often be of importance to invalids, however, that the food should be quickly digested, and the later experiments tend to confirm the general opinion that raw or soft-boiled eggs are more suitable for invalids

[1] U. S. Dept. Agri. Farmers' Bull. No. 128.
[2] U. S. Dept. Agri. Farmers' Bull. No. 128.

than those that are hard-boiled. That eggs rightly hold their position as of high nutritive value is shown by the fact that from experiments made by the U. S. Department of Agriculture, the coefficient of digestibility, that is, the per cent. of the nutrients actually digested, is for the protein of eggs 97 per cent. and for the fat 95 per cent.

COOKING

Eggs are capable of being *cooked* in a great variety of ways, and thus diversity can be given to the diet, but in general the simplest methods of cooking are the best. If an egg is boiled only two minutes, the albumin next the shell is coagulated, while the yolk remains fluid; if boiled three minutes, it is sometimes termed "solid boiled,"[1] while if boiled for ten minutes or more it is termed "hard boiled." The albumin first begins to coagulate at 134° F., and at 160° F. the whole mass is coagulated. The yolk has been found to coagulate at a lower temperature than the white. The method of plunging the egg into boiling water and boiling for three or four minutes is not to be recommended.

Eggs are much more evenly cooked if put into a vessel of boiling water, covered and immediately removed from the fire. For two or three eggs a quart of water is sufficient, and the eggs will be found to be "soft boiled" in five or six minutes. These are sometimes called "coddled" eggs. The exact time must be regulated according to the coldness of the eggs, the composition of the vessel in which they are cooked and the number of eggs treated. The temperature of the water should remain between 170° and 185° F.

In the poaching of eggs it has been recommended that a little vinegar be added to the salt water in which they are cooked, in order to assist the coagulation and prevent loss. Fried eggs are not as digestible as those cooked in other ways, as the coagulated albumin coated with fat is not as readily attacked by the gastric

[1] Loc. cit.

juice. An omelet is considered one of the most delicate and attractive of egg preparations, but the different portions of the eggs are unevenly cooked.

QUALITY OF EGGS

As eggs belong to the class of perishable products, it is evident that great care is necessary in *transporting* and *keeping* them so

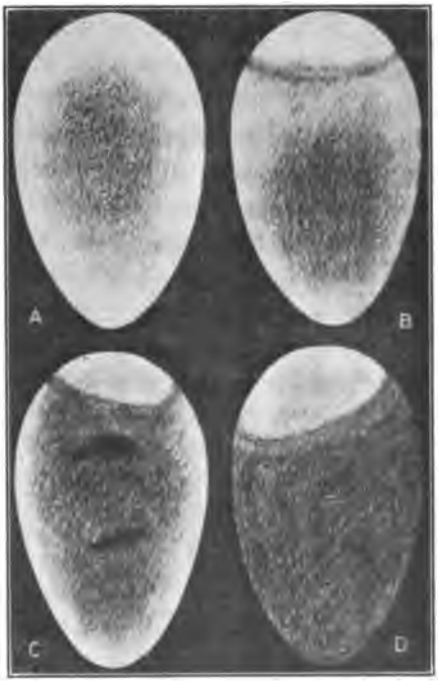

Fig. 68.—Appearance of different grades of eggs before the candle. *A*, Fresh egg; *B*, stale, shrunken egg; *C*, fungous, spot egg; *D*, black, rotten egg. (By permission U. S. Dept. Agric.)

that the quality may be unimpaired when they reach the consummer. Climatic conditions, careless handling and marketing, and low grades of poultry on the farm, all tend to reduce the quality of the product as delivered to the kitchen.

One method of testing the quality of an egg is by "candling."[1] (Fig. 68.) In this process the egg is held in a hole in an opaque shield and viewed by a bright light on the farther side. As the egg becomes older the air space at the end of the shell can readily be seen to be larger. The appearance of the yolk and its movement as the egg is rotated also assists the candler. If incubation has begun, a dark spot which is larger as the time of incubation is greater, is visible. "Spots" which are also seen in the process of candling, are particles of fungoid growth or the developing embryo. "Spot" eggs may be of various ages, and are of course inferior for food purposes, although often forced on to the market by the dealers. Heat is the most prolific source of destruction of eggs, and in transit from the farm to the consumer, eggs are liable to be exposed for a longer or shorter time to a high temperature. At a temperature of 86° F. to 91° F. an ordinary summer heat, seven or eight days only are required to equal the normal heat of incubation.[2] Unfertilized eggs keep much better than those that are fertilized.

Preservation—Preparation for Market

The best method of keeping eggs is by *cold storage*, at a temperature of about 32° F. Eggs placed in cold storage in cold weather, it has been asserted, will be in better condition in midsummer although older, than those so placed in May or June. Some packers more recently have asserted that eggs packed just before hot weather comes on, will remain fresh longer than those packed in cold weather. It is by no means implied that cold storage eggs are as good as fresh eggs, but they are frequently the only product available in the large cities, especially during the winter months. From experiments made by the U. S. Dept. of Agriculture, and elsewhere, it is evident that there should however be some limit to the time in which eggs are allowed to lie in cold storage before they are marketed.

A convenient method of handling eggs, and of keeping them

[1] Year Book, U. S. Dept. Agri., 1910, pp. 461–476.
[2] Year Book U. S. Dept. Agri., 1910.

for a limited time is by *freezing* the broken eggs. This is accomplished frequently under the most sanitary conditions, by first "candling" the eggs, then breaking each egg carefully, so as to avoid the use of any of inferior quality, mixing them thoroughly by the use of a mechanical stirrer, in a vessel surrounded by cooled brine (see Fig. 69), and finally running the semi-liquid mass into tin cans, holding from 30 to 50 pounds, and freezing the product immediately. The eggs prepared in this way will keep for

FIG. 69.—Breaking eggs (on the left). Mechanical mixer to prepare eggs for freezing (on the right). (By permission Seymour Packing Co.)

quite a time, in cold storage, and are extremely convenient for use by bakers and large food manufacturers. The eggs used in this process should be free from "spot" eggs, and of good quality. The egg should be broken, only in carefully managed establishments, and near the center or production.[1]

The *whites* of eggs may be separated from the yolks, at the time of breaking (Fig. 70), and may be frozen for the use of

[1] U. S. Dept. Agri. Bur. Chem. Circ. 98.

bakers. This is an important and growing industry. The yolks may be frozen separately, or, what is more common, mixed with the commercial broken eggs, described above. Borax is used in some countries to preserve the broken egg product.

FIG. 70.—Separation of yolks and whites of eggs previous to freezing. (By permission Seymour Packing Co.)

Use of Preserving Solutions

Among the methods that are used for preserving eggs in small quantities, there are two that have been found fairly satisfactory. The first is by covering the eggs with lime water. This method has many advocates, although others urge that the flavor of the egg is liable to be injured by the lime which penetrates the porous shell.

The second method is by the use of a solution of water glass (silicate of soda).[1,2] To obtain good results, the eggs should be

[1] U. S. Dept. Agri. Bur. Chem. Bul. No. 115.
[2] Eighth International Cong. of Appl. Chem Sec. viiic, p. 51.

perfectly fresh, the silicate solution should be made by adding one part of commercial water glass to nine parts of freshly boiled water. The eggs must be completely covered with the solution in a galvanized iron or earthen vessel and be kept in a cool place. It is said that the taste of the eggs is practically unchanged, even after ten to twelve months' storage. Eggs treated in this way crack more readily during boiling, but this may be obviated by piercing the shell with a strong needle.

Egg Preparations

On account of the difficulty of keeping eggs fresh, *dessicated* or *dried eggs* and egg powders have been put upon the market. Desiccated eggs can be prepared by spreading the eggs over the surface of a slowly revolving cylinder, upon which a current of warm air is blown, or the semi-liquid eggs can be dried in a vacuum. Salt or sugar is sometimes added to assist in preserving the product. A recent method of drying is by allowing the beaten eggs to flow in a thin stream upon a wide block-tin belt, which moves slowly over revolving cylinders, in such a way that the thin film of egg is heated carefully, but never to a temperature about 120° F., lest the albumin be coagulated. This product is scraped off the belt, and dried more completely in wire boxes, and finally packed in barrels for transportation. It is intended for temporary use only, and must be kept in cold storage. From the standpoint of healthfulness there is no objection to desiccated eggs if made from good stock in the proper manner. The product is used by bakers and others, and has the advantage of keeping in localities and under conditions where fresh eggs are not available.

There are occasionally found on the market, *egg substitutes* which are made of the casein and albumin of milk mixed with flour to form a paste or powder. Gelatin, isinglass and gluten are used in the same way. Other egg substitutes which are of course worthless, consist largely of starch or flour, colored with aniline yellow, so as to resemble eggs. They may not be injurious, but they are intended to lead the customer to think he is getting something "just as good" as eggs; when as a matter of fact he is buying at a high price, cheap materials which have none of the properties of eggs.

Eggs are produced all over the United States, but it is only the states of Ohio, Indiana, Illinois, Iowa, Minnesota, Nebraska, Kansas, Missouri, Texas, Tennessee and Kentucky that produce more eggs than are needed for home consumption, and can export to their less fortunate neighbors.

England is largely dependent on the Continent for its egg supply. The price of eggs in the United States varies with the time of the year, but in general is gradually increasing.

The United States Agri. Dept. report for the year 1911–12 gives the egg exports as 15,405,609 dozens, valued at $3,395,952. The new American tariff, placing eggs on the free list, has resulted in the importation of a large number of eggs from China.

CHAPTER XVIII

SPICES AND CONDIMENTS

Spices and condiments are of extremely varied composition. They are used to communicate an agreeable flavor or aroma to food, and to stimulate the appetite. With the possible exception of common salt none of these substances can be said to be absolutely necessary to the human body. They may however be used with moderation by middle-aged and old people to give increased pleasure in partaking of food, but the use of spices by children should not be encouraged. Condiments are not to be regarded as food, for they do not contribute directly to the nourishment of the body, but they are to be regarded as simply "food accessories."

ESSENTIAL OILS

Many of these substances owe their properties to the presence of a volatile oil, which excites the nerves of taste and smell and thus increases the desire for food, or as we say the appetite. The essential oil which many of them contain is readily distilled over with steam, and forms an important article of commerce. This oil is sometimes used in the place of the material from which it is made, as in the case of the oil of cloves, cinnamon or thyme. These oils usually contain a number of closely related compounds, among which are the terpenes ($C_{10}H_{16}$), and camphors ($C_{10}H_{16}O$). The composition of some of the more important essential oils is considered under the spices mentioned below.

CLASSIFICATION

For convenience the spices and condiments may be classified with reference to the source from which they are obtained, thus: 1. *From stems or leaves;* 2. *from buds or flowers;* 3. *from the bark;* 4. *from roots or rootstocks;* 5. *from immature or ripe fruits;* 6. *from seeds.*

1. FROM STEMS AND LEAVES

Bay leaf (Laurus nobilis L.).—The sweet bay as it is called is used as a condimental substance in food. It is a native of the Mediterranean but grows in sheltered gardens in temperate climates. The oil of bay, which is used in making bay rum, is obtained from a different plant, the Myrcia acris.[1]

Sage (Salvia officinalis L.) is an ordinary perennial garden herb, which grows wild in southern Europe, and is cultivated in old time gardens. The leaves, which are the official portion, are grayish green, hairy and very aromatic. From these an aromatic oil may be distilled. It possesses slightly tonic, astringent and aromatic properties. Its chief use is in flavoring meats, especially sausage, and the "stuffing" of fowls.

Spearmint (Mentha spicata L.) is the dried leaves and tops of a perennial herb, which is a native of Europe and Asia but has become naturalized and is found in moist places in many localities in the northern United States. It somewhat resembles peppermint, but can readily be distinguished from it both by appearance and odor. The plant is used especially in flavoring "mint sauce," which is served with mutton. The oil of spearmint is largely distilled in this country, the whole plant being used.

Sweet majorum (Origanum majoranum).—This plant grows wild in Portugal and Andalusia, is a native of North America, and is cultivated as a garden herb in many countries. It yields a volatile oil when distilled with steam. The plant is used in medicine and for flavoring.

Sweet basil (Ocymum basilicum L.).—This is an aromatic plant which is a native of India and Persia,[2] but is cultivated in

[1] U. S. Dispensatory, p. 1589.
[2] Loc. cit., p. 1584.

gardens throughout the temperate zone. The leaves are used for condimental purposes, on account of their aromatic flavor. The flavor somewhat resembles that of cloves.

Summer savory (Satureja hortensis L.) is an annual plant which suggests thyme by its odor, and which grows wild in southern Europe. This and the mountain savory are grown for flavoring soups, entrees, etc. This plant readily yields an aromatic oil upon distillation.

Peppermint (Mentha piperita L.) or "mint," is found growing wild in moist places in almost all countries of the temperate zone. It is also cultivated for mkaing the essential oil especially in the states of Michigan, Indiana and New York. The oil which has a strong, pungent taste, "followed by a sensation of cold when air is drawn into the mouth," is not so much used for flavoring foods as in beverages and confectionery. Menthol ($C_{10}H_{19}OH$) is obtained from oil of peppermint.

Parsley (Apium petroselinum) is an umbelliferous plant which is a native of Sardinia and parts of southern Europe, and is readily cultivated. All the parts of the plant contain an oil to which the flavor is due. A peculiar substance called *apiin*, which suggests pectin because it readily forms a gelatinous mass, is obtained by boiling the herb with water and cooling. Various parts of the plant are used in medicine, but the amount used in garnishing and flavoring foods is not sufficient to produce any medicinal effects.

Tarragon (Artemisia dracunculus) is a plant which is cultivated for its pungent, aromatic leaves. They are used more especially as a flavor in western Asia. Their principal use is for flavoring soups, and for making "tarragon vinegar," which is well known and appreciated in many countries.

Wintergreen (Gaultheria procumbens L.) is a small evergreen herb which grows wild in various parts of the United States. The oil is especially used for flavoring beverages and confectionery. It contains about 95 per cent. of methyl salicylate and may be used as a substitute for salicylic acid in medicine.

Thyme (Thymus vulgaris L.) is cultivated in gardens throughout the temperate zone, and is a native of the Mediterranean region. There are several allied varieties having quite similar properties growing wild. The oil of thyme, which is produced from the leaves by distillation, contains from 25 to 42 per cent. of *thymol* ($C_{10}K_{13}OH$). Thyme is used for flavoring foods.

2. BUDS AND FLOWERS

Caper bush (Capparis spinosa L.).—Capers are the buds or unexpanded flowers of a low trailing shrub that grows abundantly along the shores and on the islands of the Mediterranean. It is found growing wild in central and southern Italy, and is cultivated in that country and on the islands of Sicily and Majorca, as well as in France and Spain. The fresh buds gathered every morning are treated with salt and vinegar. The smallest and greenest are considered of the finest quality. Capers are used especially for flavoring meats and in pickles. The peculiar flavor of capers is due to the presence of capric acid. They are sometimes adulterated by the substitution in part of other flower-buds.

Cloves (Eugenia caryophyllata or Caryophyllus aromaticus L.).—The dried flower buds of an evergreen tree which is a native of the Molucca Islands. It is cultivated throughout the East Indies, in East Africa and in the West Indies and Brazil. The tree grows to a height of 30 or 40 feet and begins to bear when the tree is about six years old. The cloves are dried in the sun or by the heat of a wood fire. Cloves contain from 17 to 20 per cent. of the volatile oil of cloves, and about 8 per cent. of oleo-resin. The oil is obtained by distilling the cloves with water, and it is to the presence of this oil that we owe the agreeable flavor and aroma. This oil consists of about 90 per cent. of a substance called "eugenol" ($C_{10}H_{12}O_2$). The uses of cloves in culinary operations as a flavor, and as a preservative are well known. Exhausted cloves from which much of the oil has been removed are sometimes found upon the market. Formerly, ground cloves were very grossly adulterated, but this condition does not at present prevail in the United States.

Saffron (Crocus sativus L.).—This is the dried stigmas and tops of the styles of a perennial plant which is originally from Asia Minor, but is now cultivated in many parts of southern Europe and Asia. It is chiefly used in medicine and to impart color and flavor to food.

3. BARKS

Cassia (Cinnamomum cassia and several other species).—This is the inner bark of various trees having an odor and flavor quite similar to cinnamon, and often used as an adulterant for the genuine cinnamon. It contains a volatile oil similar to oil of cinnamon. The flower buds are put on the market under the name of "cassia buds," which are also used for flavoring purposes.

Cinnamon (Cinnamomum zeylanicum Breyne).—This is the true or Ceylon cinnamon and is the inner bark of a tree which is cultivated throughout the East Indies and in various tropical countries. The longitudinal strips of bark are removed from the trees, cured and dried, and made into bundles for shipping. This bark contains an essential oil, usually less than 1 per cent., which consists largely of "cinnamic aldehyde" (C_6H_5 CH : CH.-CHO).

An artificial (synthetic) cinnamic aldehyde, made from coal tar is sometimes used to replace the genuine oil in the manufacture of flavoring materials. The cinnamon bark can readily be adulterated with cassia and similar barks. Pure ground cinnamon is much more frequently found on the market than formerly.

4. ROOTS AND ROOT-STOCKS

Turmeric (Curcuma langa).—This is the rhizome of a perennial plant growing in the East. The roots are dried and frequently ground before being put upon the market. It contains a yellow coloring matter, and the powder has a warm, bitterish, somewhat aromatic taste. It is used for coloring and flavoring food products.

Garlic (Allium sativum) these bulbs, which are much more commonly grown in Europe than in the United States, are used in flavoring, sauces, etc. (See Onions.) The odor is due to an essential oil, which is usually supposed to consist largely of allyl sulfide (C_3H_5S or allyl sulfocyanide (C_3H_5NCS).

Ginger (Zingiber officinale).—This is the creeping rhizome of a plant which is said to be a native of Hindostan, but is cultivated in the East and West Indies, Africa, China, Japan, and in fact almost all sub-tropical countries.[1] The root is sufficiently grown when it is a year old. It is scalded in boiling water, rapidly dried and thus prepared constitutes the "black ginger" of commerce. In Jamaica the white or Jamaica ginger is prepared by peeling the fresh rhizomes and mascerating them with water or lime juice, and drying in the sun. Inferior grades are often bleached with sulfur or whitened by dipping into a mixture of calcium sulfate or chalk and water. "Limed" ginger has come to be a regular article of commerce. Ginger contains an oleoresin, a volatile oil and nearly 50 per cent. of a peculiar starch. The flavor is due to the volatile oil and the pungency to the oleoresin. The extract and "essence" is much used in the preparation of beverages. It is sometimes "fortified" by the addition of capsicum. Exhausted roots and adulterated ground ginger are occasionally sold.

Horseradish (Cochlearia armoracia L.) is the root of a plant which is a native of western Europe and is extensively grown on both sides of the Atlantic. The virtue of the root is due to the volatile oil which is present, but which is dissipated by drying. The root is grated and preserved in vinegar for use. The oil consists chiefly of sulfocyanate of butyl (C_4H_9CNS). Horseradish is valuable as an addition to a diet containing much salt meat, as it tends to prevent scurvy. As a condiment it promotes the appetite and assists digestion, if not taken in too large quantities.

[1] U. S. Dispensatory, p. 1326.

The grated horseradish is sometimes mixed with grated turnip as an adulterant.

Sassafras (Sassafras variifolium).—This is a small tree growing along the Atlantic coast, and to the interior of the United States. The bark of the small stems and especially of the root is the part used. The root and the volatile oil obtained from it are used in flavoring beverages and confectionery.

5. IMMATURE AND RIPE FRUITS

Allspice (Pimenta officinalis).—This is the dried ripe or nearly ripe fruit of an evergreen tree, growing to a height of about 30 feet, which is a native of the Caribee Islands, but is grown in the West Indies, Mexico and the northern part of South America. The berries, in order to have the best flavor should be picked while green, and are then dried in the sun or in a kiln. The volatile oil which is present to the amount of from 3.5 to 4 per cent.,[1] has a fragrant odor which resembles somewhat a combination of other spices.

Capsicum—cayenne pepper—(Capsicum frutescens L.) and several other species. There are several species of red peppers; the cayennes are hot and the "paprikas" are mild. Peppers are cultivated in both the temperate and sub-tropical countries, but the pungent varieties are more extensively used in the latter.

Paprika—(Capsicum annuum L.) is the dried ripe fruit, exclusive of seeds and stems, of several large fruited species of capsicum. When ground into powder, it constitutes the "paprika" or "sweet pepper" of commerce, and has a comparatively mild taste. It is often mixed with genuine pepper.[2]

Juniper (Juniper communis).—This is a dark blue berry, borne on an evergreen tree that is one of the most widely distributed trees of the northern hemisphere. It grows as far north as the arctic circle, and the trees differ greatly in size and shape

[1] U. S. Dept. Agri. Bull. No. 13, p. 229.
[2] U. S. Disp., p. 289.

in different latitudes. The fruit matures during the second season, and is used medicinally and for making an aromatic oil. The crushed berry or the oil is used in flavoring gin. (See p. 147.)

Pepper (Piper officinarum—Piper nigrum L.).—P. nigrum L. grows wild in China and various parts of India and is cultivated principally in the East Indies. This is a perennial plant, which is propagated by cuttings, and as it grows must be supported by props or other trees. The tree begins to bear three or four years after it is planted and produces two crops a year. *Black* and *while* pepper are the fruit of the same tree, but treated in different ways. The berries which are gathered before they are ripe, are dried in the sun, and beaten on mats to detach them from the stalk. This constitute the *black pepper* of commerce. For the preparation of *white pepper*, the berries are allowed to become red or even black before they are gathered, and then are permitted to stand until a certain amount of fermentation takes place. They are then rubbed between the hands to remove the pericarp and pulp, dried and blanched. The white pepper is much less pungent, but more aromatic than the black. One of the most important ingredients of pepper is *piperin* ($C_7H_{19}NO_3$), an alkaloid-like substance. Pepper also contains an oleo-resin and a volatile oil which contribute flavor and pungency to the product. The P. officinarum or *long pepper*, is a smaller berry than the P. nigrum, and not so generally used.

Vanilla Bean (Vanilla planifolia, Andrews).—This is the dried and cured bean of an orchid which is indigenous to Mexico, but is also cultivated in the West Indies, Central and South America. The best cured beans of commerce are from 20 to 25 centimeters long, and drawn out at the ends and curved at the base. They have a very characteristic dark brown color, are waxy to the touch, and covered with fine crystals of vanillin. (Fig. 71.) The delicious flavor is developed in the process of sweating or curing, which must be done with great care and skill. Mexican beans command the highest price, often from $10.00 to $15.00 per pound. The cheapest grades are from South America and Tahiti.

Vanillin, the active principle of these beans, and the substance to which the flavor is due has the composition, $C_8H_8O_3$ and is found in quantity from 1.60 per cent. to 2.60 per cent. It is readily extracted by alcohol and other solvents. An artificial or "synthetic" vanillin has been made, and is much cheaper than the product from the vanilla beans. It is largely obtained by the oxidation of the eugenol of oil of cloves with alkaline potassium

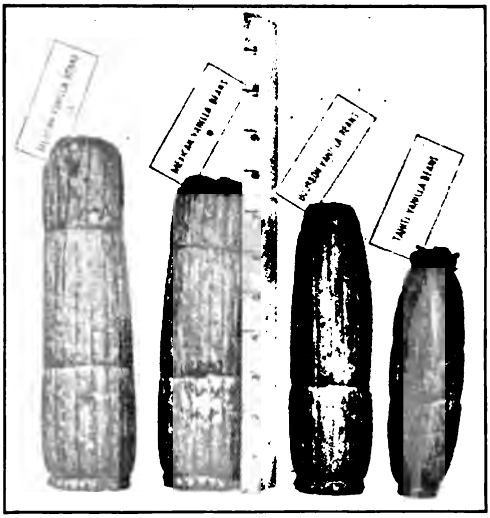

FIG. 71.—Bundles of vanilla beans, as they come into the market. (By permission U. S. Dept. Agric.)

permanganate.[1] *Vanilla extract* is made by extracting the vanilla beans with dilute alcohol, and adding a little sugar or sometimes glycerine. There are many fraudulent extracts on the market.

6. SEEDS

Anise (Pimpinella anisum L.).—The seed of an annual plant which is a native of Egypt, and is cultivated abundantly in Malta,

[1] Food Adult. and Anal., Leach, p. 730.

Italy, Spain, southern Russia, in India and South America. Anise is interesting as being one of the earliest aromatics mentioned in literature. It contains about 3 per cent. of volatile oil to which the warm, sweet aromatic taste and odor is due. Anise is used in flavoring pastry and in making various liqueurs and cordials.

Cardamon (Elettaria cardamomum).—The Cardamon is a native of *Malabar* and is produced chiefly in India. The seeds grow on a small tree, which begins to yield fruit at the beginning of its fourth year. After they are picked the seeds are washed several times in soap solution, and then thoroughly dried. Cardamons are used in cakes, sauces, cordials and confectionery.

The **Tonka bean** is the seed of a large tree which grows in Guiana—the Dipteryx odorata. The almond-shaped pod contains a single bean, something like a kidney bean in shape, and having a brown color. *Coumarin* ($C_9H_6O_2$) is the active principle of the tonka bean. It is the aldehyde of coumaric acid and forms colorless prismatic crystals, which have a fragrant odor and bitter taste. It may also be prepared synthetically. Tonka extract is often used to partly replace vanilla extract, or it may be used with artificial coumarin and vanillin to form a cheap "compound" extract of vanilla.

Caraway Seed (Carum carvi L.).—The plant is a native of Europe, and is cultivated in many countries. The seeds yield on distillation an essential oil which contains a substance called "carvol" ($C_{10}H_{14}O_6$). They are used for flavoring and in cooking.

Celery Seed (Apium graveolens L.).—The seeds of this plant are often used for flavoring purposes, and have considerable medicinal value. (See Celery p. 184.)

Coriander Seed (Coriandrum sativum L.).—A native of Italy, which grows wild in some parts of Europe and is readily cultivated. The volatile oil has an agreeable odor.

Cumin Seed (Cuminum cyminum L.).—A native of Egypt, and at present cultivated largely in southern Europe. This is an annual umbelliferous plant, which produces a seed quite similar to the coriander in flavor. It is used in flavoring. In Germany the peasants are fond of bread and cake flavored with cumin, and in Holland it is used to flavor cheese.[1]

Dill (Anethum graviolens L.).—This plant is a native of Spain, Portugal and southern France, and is cultivated in gardens in Europe and America. The seeds are used in the United States for flavoring, and in preparing a special pickle known as the "dill pickle." The flavor is not as agreeable as that of fennel.

Fennel (Fœniculum vulgare L.).—This plant which is a native of Europe, is common in all temperate climates. The seed generally yields four or five per cent. of volatile oil, which has a sweet aromatic taste. Fennel is chiefly used to flavor cakes and liqueurs.

Grains of Paradise (Amomum melegueta).—These seeds are grown in West Africa and the West Indies, and are used as a codiment. As they have a pungency similar to black pepper they are used to give a "fiery" taste to various liquors as beer, wine and gin.

Mustards (Sinapis arvensis, var. nigra and alba L.).—These plants are probably indigenous in Europe. They are cultivated in gardens and in fields and in some places grow wild. Both the black and white mustard are important condimental substances. The plant is an annual, bearing yellow flowers, and the seeds may be separated from the pods when ripe by threshing. Mustard contains a *fixed oil* which is present to the amount of from 20 to 30 per cent. This may be expressed from the powdered seeds, after warming. It is a bland oil, with very little taste, and forms an excellent salad oil. (See Fats and Oils.) Much of the fixed oil is frequently removed before the seeds are prepared as "ground mustard." Mustard also yields, when the seeds are moistened, under the influence of the *myrosin* an enzyme, a volatile or essential oil, but this does not exist ready-formed in the seeds. The active principle of black mustard is *sinigrin*, and that of white mustard is *sinalbin*. These are the substances which break up

[1] Foods, Origin, Comp. and Manufacture, Tibbles, p. 764.

to yield, among other products, the volatile oil. The strongest "ground mustard" is obtained by mixing the two varieties of seeds. As starch is not a constituent of mustard, adulteration with this substance is easily detected. Formerly the "prepared mustard" put upon the market in the United States, was grossly adulterated. The uses of mustard in medicine, as a condiment, and to stimulate the appetite are well known.

Nutmeg—Mace (Myristica fragrans Houttuyn) and other varieties. These seeds grow on a tree about 30 feet high, which somewhat resemble the orange tree.[1] It is a native of the Molucca and neighboring islands, and is cultivated especially in the East Indies, Madagascar and the West Indies. The trees are started from the seed, but are cut down and grafted with branches of the female tree to insure fruitfulness when they are about two years old. A few male trees are left in the orchard to insure fecundation. The trees continue bearing for seventy or eighty years. The nutmegs are gathered by hand and the interior covering (the mace of commerce) is carefully removed. The nuts are then dried and exposed to smoke until they become brittle enough to be readily broken so that the kernel (the nutmeg of commerce) can be easily separated. The kernels are steeped in lime water or rubbed over with dry lime, to prevent their being attacked by insects, before they are exported. Nutmegs contain an expressed oil, which becomes solid on cooling, and consists largely of *myristin*, and a volatile oil which is obtained by distilling the powdered nutmegs with water. The nutmeg is aromatic and a stimulant,very useful for flavoring food products. Mace has similar properties to those of the nutmeg. Bombay mace, which is often used to adulterate Penang and other true maces, has practically no flavor, and is of little more value than so much inert material.

SALT (Sodium chloride, NaCl)

Salt seems to have been in use by man from the earliest ages. In some countries it has been held of such value that it has sold

[1] U. S. Dispensatory, p. 797.

at an extremely high price. It occurs in the ocean, in salt lakes and salt springs, as well as in immense salt beds, from which it can be mined. The methods of obtaining salt are as follows:

1. *By the Evaporation of Ocean, Salt-lake or Salt Spring Waters.*

Each gallon of sea water would yield about one-fourth of a pound of salt, and for many years this was almost the only source of the salt of commerce, especially in warm dry climates. Salt is still made by the solar evaporation of sea or salt-lake water in Portugal, Italy, Spain, Austria, France and California. In Russia and Siberia the sea water is first frozen, and the ice which is then removed contains but little salt, and the remaining brine is boiled down. Salt made from ocean water is quite impure, unless purified by washing and recrystallization.

2. *From Rock Salt*

Beds of rock salt of great extent, formed by the evaporation of prehistoric seas, are found in many parts of the world. In the United States these beds occur especially in New York, Michigan, Kansas and Louisiana. They are sometimes near the surface but often at a depth of a thousand feet or more. The salt is mined by sinking a shaft and working similar to a coal mine. The rock-salt, if sufficiently pure, is sold just as mined, or gound and screened, and put upon the market directly. This product is often 98 to 99 per cent. pure.

3. *By Evaporating a Brine Obtained From Salt Beds*

This is one of the commonest and most satisfactory methods. A drilling is made into the salt, and lined with tubing, another tube is hung loosely in this outer tube, leaving an annular space, between the two thus (⊙). Fresh water is pumped into this annular space, becomes saturated with salt in the strata below, and is subsequently pumped out, and evaporated. This evaporation is carried on by solar heat, in open pans heated directly over a fire, or heated by steam or more recently in open pans connected with an exhaust or vacuum pan. The brine may be somewhat purified at first by partially concentrating in a pan where the less soluble constituents, such as calcium sulfate crystallize out, and then running into the main evaporating pan. The salt is raked out of the pans, allowed to drain, and sometimes dried artificially before it is put upon the market.

Composition

The analysis of average common salt is as follows:

Sodium chloride	98.25
Insoluble residue	0.08
Calcium sulfate	1.31
Magnesium chloride	0.10
Sodium sulfate	0.26
	100.00

Although there is an abundance of salt in the United States, considerable quantities are imported, especially for salting meats.

In some countries as Australia, Italy and China, the manufacture and sale of common salt in a government monopoly, and the salt is sold at a high price in order to produce revenue for the Government. In France, Germany and India, salt to be used for food is subject to a tax, and salt used for other purposes is "denatured," by the addition of some foreign material so that it shall not be fit to use for seasoning food.

Dietetic Use of Common Salt

The amount of sodium chloride taken with the food is so large that the chlorine contained in foods in the form of mineral salts, is of no importance. It is interesting to note that among animals the herbivora require salt in their food, while the carnivora do not. In discussing the natural craving for salt experienced by man and the herbivorous animals, Bunge[1] (Physiological and Pathological Chemistry) explains it about as follows: "Most vegetables are rich in potassium which is ultimately eliminated in the form of mineral salts, largely as sulfate. Potassium sulfate in the blood reacts to some extent with sodium chloride forming potassium chloride and sodium sulfate, both of which are rapidly eliminated by the kidneys. Hence the greater the amount of potash in the food, the greater the loss of sodium and chlorine from the blood, and the greater the necessity for salt to keep up the normal sodium chloride content of the body." Bunge in continuing this discussion concludes that while one might live without the addition of salt to the food, even on a diet largely vegetarian, without salt he would have a disinclination to eat much of the vegetables rich in potassium, such as potatoes, so the use of salt tends to enable us to utilize a larger variety of the earth's food products. Excessive amounts of salt are probably injurious as it overstimulates the digestive tract, and may overtax the organs concerned in its elimination.

[1] Chemistry of Food and Nutrition, Sherman, p. 263.

CHAPTER XIX

NON-INTOXICATING BEVERAGES

From very early times man has prepared mildly stimulating non-intoxicating beverages from various vegetable substances. It is rather remarkable that people of different nationalities, living under entirely different conditions of civilization, some earlier and some later in the history of the development of the race, should have felt the necessity, or should have appreciated the satisfaction to be derived from the use of this class of beverages, and that they selected for making them plants that continued, in a general way, similar constituents.

The most important principle contained in these beverages is the *alkaloid*, a nitrogenous substance which has stimulating properties. Tea, coffee, and cocoa contain also a volatile oil, which gives an agreeable odor and taste to the beverage, and a considerable amount of an astringent principle related to tannin, which modifies the taste and has also a physiological action on the system. Other plants, used more generally in South America, Africa and the East Indies than in North America and Europe, such as Maté, Khât, Kola, Guarana and Coca, contain similar constituents.

TEA (Thea chinensis)

History

This plant grows in sub-tropical regions which have a rainfall of 60 inches or more. The species found growing wild in Assam and Burmah is supposed to be the progenitor of the modern tea plant. Some species still grow wild in the mountainous regions of China and (India). The natives of China relate a legend that is supposed to account for the origin of tea. A Buddhist priest came from India to China, and as he was a devout man, he wanted to spend much time in prayer, but was hindered by the fact that he was overcome by sleep. In despair he cut off his eyelids and threw them on the ground, and the next day he found growing in the same spot the tea plant, the leaves of which furnished a beverage that would prevent sleep. Tea has been used in China for four thousand years or more.

FIG. 72.—A tea plantation in China. (By permission Chase & Sanborn.)

The tea plant was introduced into Japan in the thirteenth century[1] and was imported in commercial quantities into England in 1673, although a tea-house had been established in 1657 in London. At first it sold at the rate of $50.00 per pound. Besides China, Japan, and Assam, tea is also grown in Ceylon and Java, and to some extent in Brazil. The first plantation in Ceylon was opened up in 1867, and so rapidly has the industry grown, that in 1909 over 192,000,000 pounds was raised.

[1] Foods, Their Origin, Composition and Manufacture, Tibbles, p. 779.

Cultivation of the Plant

The tea plant is a small shrub, growing to the height of 3 or 4 feet if cultivated, but if allowed to grow without pruning it reaches a much greater height. (Fig. 72.) The leaves are ready for picking in three years after the plant is started, and in some countries as India are picked as often as twenty-five times a season.[1] The plants are started in the nursery from seeds, and then transplanted to the field where they are set in rows about 4 feet apart. The vigorous pruning to which the shrub is subjected causes it to send out numerous young shoots.

Manufacture of Tea

There are in general two kinds of tea on the market, green and black, both made from the same stock but by different methods of treatment. *Green tea* is made by first drying the leaves and then heating them below the boiling point of water with constant stirring in a pan over a fire, or with steam. The next process is to roll the moist leaves into balls by hand, allow them to sweat for a short time in heaps and again roast them gently. By this process the aroma is distributed and the green color is retained. The leaves are then sifted and sorted into different grades, and again roasted. In some countries a part of this process is done by machinery.

Black tea is made by first withering the leaves on trays in the sun then tossing them in the air until they are soft, and finally piling them in heaps in a cool place to ferment for some hours. When the fermentation is complete the leaves are heated over a fire, then rolled by hand upon a rattan table. Some of the black teas, as the Congous, are heavily fermented. Once more the leaves are exposed to the sun, and then roasted and rolled a second time. After roasting and rolling three times, the tea is sifted, dried and packed. Great skill is necessary so that the leaves be fermented and roasted enough to eliminate the raw flavor, de-

[1] U. S. Dept. Agri. Div. Chem. Bul. 13, pt. 7.

velop the aroma, and prevent their souring with age, and yet so that the fermentation be not carried far enough to destroy the agreeable flavor.

India teas are usually stronger than those from China and Japan. In India and Ceylon much of the work of curing tea is done by machinery, while in China, the tea leaves are manipulated by hand, or sometimes even by the use of the feet.

In the process of manufacture of tea the cells are broken and the volatile oil has an opportunity to diffuse through the whole mass. Much moisture is lost in the process, so that only about 25 pounds of tea are obtained from 100 pounds of leaves.

Composition of Tea

The average composition of tea leaves according to König[1] is as follows:

Water	9.51
Nitrogenous substances	24.50
Theine (or caffein)	3.58
Essential oil	0.68
Fat, chlorophyl and wax	6.39
Gum, dextrin, etc	6.44
Tannin	15.65
Pectin, etc	16.02
Crude fiber	11.58
Ash	5.65

The most important of these constituents are the thein, volatile oil and tannin; and to these most of the characteristic qualities of tea are due. The amount of tannin varies widely, from 5 to 20 per cent. Tea contains about 0.5 per cent. of volatile oil. According to Allen, the amount of caffein is from 1.35 to 4 per cent. Graf[2] believes that in Souchong and Congou teas, the higher the amount of caffein, the better the quality of the tea; that is, if quality may be judged by price. This is not true, however,

[1] From Leach, Food and Drug Analysis, see König.
[2] J. S. Ch. Ind. Vol., 1, p. 694.

of the Indian teas According to Y. Kozai[1] the following analyses show the relative quantity of some of the important ingredients in green and black teas.

	Green tea	Black tea
Crude protein	37.43	38.90
Fibrin	10.06	10.07
Ash	4.92	4.93
Theine	3.20	3.30
Tannin	10.64	4.89
Total nitrogen	5.99	6.22

It will be noticed that the important difference in the two kinds of tea is the greater per cent. of tannin contained in the green tea. In the process of manufacture of black tea, some of the tannin is oxidized and made less soluble. The chief agent in the fermentation and coloring of tea is an enzyme or oxidase which is present in the leaves.[2] There is the largest quantity of this enzyme in the tip leaf of the shoot, and the least in the old leaves. The leaves containing the highest per cent. of this enzyme are those that give the highest flavored teas. It has been shown that this enzyme converts some of the tannic acid into glucose.[3]

It is stated[4] that the principal constituents of the essential oils, which give the characteristic aroma to tea are originally present in a glucosidal combination, and are liberated by hydrolysis during the fermentation of the tea.

Varieties of Tea

The varieties of tea which are very numerous, depend on the country in which the plant is grown, on the altitude, the climate, and especially on the age of the leaves when picked. A few of

[1] Practical Dietetics, Thompson, p. 211.
[2] Maun, J. Asiatic Soc. Bengal, 70–154. Abst. J. S. Ch. Ind. Vol. 21, p. 716.
[3] Newton, J. Soc. Ch. Ind., Vol. 21, p. 182.
[4] Hartwich and Du Pasquier, Apoth. Ztg., 24, 109. (Abst.) Chem. Abst., Vol. 3, p. 2594.

India and Ceylon teas found on the English market may be mentioned.[1]

Flowery Pekoe or tip leaf of the tea, which is really an unopened bud; the *Orange Pekoe* which is the next leaf; the *Pekoe,* which is made from the leaf next in order on the stem; *Souchong,* made from the leaf below the latter; and *Congou* and *Bohea* the largest leaves. The term Pekoe is generally applied to the first, second and third leaves, and Souchong to the larger and older leaves. These teas are scented artificially by packing orange or jessamine flowers on top of the tea in the chest, and thus allowing the flavor to permeate the whole mass.

The *China* teas include the following green teas, *Young Hyson,* made from the leaf buds picked early in the season; *Gunpowder,* a Hyson flavored with the leaves of the sweetscented olive; *Imperial,* a larger leaf; and *Twankay,* a low quality of green tea.

The prejudice that formerly existed against green teas in the United States, has been largely done away with, since the Act of Congress in 1897 "to prevent the importation of impure and unwholesome teas." A Government expert at each of seven ports of entry compares all teas with the standards and only admits those of known purity.

Among the *black teas* may be mentioned: Congou which is in the United States used as a synonym for English breakfast teas which come from both north and south China; Pekoe, which has been already described; Monings, a delicate leaf from northern China, Kaisows from southern China; Oolong, an unfermented tea from Formosa, Souchong and scented orange Pekoe. The Indian teas, mostly black, include the Assam and Darjeeling, of which the latter is the choicest. It is grown on the sides of the mountains often at a height of 3000 feet. In the United States the green teas are more favored in the Middle West, while the Oolongs are popular only in New York, Pennsylvania, and the Eastern States. In England the Ceylon and India teas are used to the extent of 90 per cent.

[1] Foods, Origin, Composition and Manufacture, Tibbles.

Different varieties of teas are often blended, especially in preparing a black tea for the market. This blending is very skillfully done by professional tea-tasters, who mix various kinds of tea in such a way as to obtain a satisfactory body, strength, aroma and flavor. The different varieties of China, India, Ceylon and Japan teas are so numerous that it is estimated that at least 2000 different flavors may be obtained.

Adulteration and Substitutions

Formerly a large quantity of adulterated tea was imported into the United States, but since the careful inspection of all teas by the general government, although teas of low grade are admitted, adulterated teas are rare.

The mixture of the leaves of other plants, especially those of the willow, poplar, elder, birch and elm, with those of tea was at one time practised, but this deception can be readily detected by the use of the microscope. Exhausted tea leaves, collected from hotels and restaurants, have been colored, faced and rerolled to represent genuine tea. Green tea is sometimes "faced" with pigments to impart to it a fresh color and make the "product appear better than it really is." Some of the materials used for this purpose are prussian blue, indigo, graphite, turmeric and gypsum. The use of these substances gives an opportunity to use foreign and spent leaves, as well as brick dust and other mineral matter, which increases the weight. A product called in China "lie tea" has been also found on the market. This consisted of tea siftings and fragments of leaves, foreign leaves and mineral matters held together by a starch solution and colored to resemble tea.

"Tea dust" is allowed as an admixture with the imported tea, if it does not exceed a small specified per cent. It is used for the manufacture of caffein, and is also sold for use in making tea, epecially when made on a large scale as at hotels and restaurants. Astringents, like catechu are sometimes added to tea for the purpose of giving it an appearance of greater strength.

"Tea Tablets" made of finely ground tea, especially that from India and Ceylon, probably more liable to adulteration than the ordinary leaves, are upon the market for the use of travelers.

Preparation of the Beverage

In making tea, as the tannin is extracted by protracted heating or "drawing" the tea leaves should be in contact with the hot water only long enough to extract the volatile oil and some of the caffein. If the water is fresh, and is allowed to boil furiously for two minutes, and is then poured on the tea leaves and allowed to stand in an earthenware teapot not over five minutes and then poured off into another heated vessel, the beverage will contain a minimum amount of tannin and retain its taste and aroma. Boiling or steeping for any length of time, materially injures the delicate flavor of tea. By the use of a "tea ball" in which about a teaspoonful of tea is placed, each consumer can make the tea of whatever strength he desires.

About 5 grams (75 grains) of tea, with a pint of boiling water should be used in making five cups of the infusion. A cup of tea ordinarily contains 0.4 grams of soluble substances, and 0.025 of thein.[1] There are quite a large number of other active bodies in the tea infusion in addition to those mentioned, such as a xanthin, a diuretic base, an acid, gums, resins and mineral matter. Although it is possible to extract from commercial tea from 31 to 44 per cent. of extractive material, the ordinary infusion if properly made, seldom contains more than 20 to 25 per cent.

The kind of water used in making tea is also of importance. An absolutely soft water does not give as satisfactory a beverage as that containing small quantities of calcium carbonate (lime) and other mineral salts.

Physiological Action of Tea

Tea acts as a mild stimulant and relieves fatigue. It has been found to be especially soothing and grateful to elderly people

[1] Loc. cit.

when the digestive system is weakened. It assists in mental and muscular work, accelerates the circulation of the blood,[1] renders active the functions of the skin and the excretion of the urine, and reacts usefully upon the greater part of the other functions. An excess of tea is however liable to precipitate the digestive ferments, retard digestion and produce insomnia and nervousness. Tea should be avoided by those who suffer from dyspepsia or constipation. The "tea habit" produces overstimulation followed by depression and later by muscular tremors and palpitation. Tea is not a food, although if cream and sugar are used with the beverage a small amount of nutriment is thus obtained. Lemon juice added to tea often makes it more acceptable. Tea is not an expensive beverage, and so it is utilized and appreciated by people of small means. A very high grade of tea only costs 1/2 cent per cup, and a grade that sells at 50 cents per pound affords the beverage at the rate of from four to six cups for 1 cent.

In the United States the amount of tea used per annum per capita is about 1 pound, while in England it is 6 pounds, and in Australia 7 pounds. In the whole world it is estimated that 2,500,000,000 pounds of tea are consumed each year. For use in the United States 98,706,241 pounds were imported in 1912.

TEA SUBSTITUTES

Coffee-leaf tea is an important beverage in some coffee-producing countries, and the beverage has about the same constituents and properties as ordinary tea.[2] Other beverages are made from herbs which contain essential oils or flavoring materials, and these, when made into hot infusions, have a slightly stimulating effect, although the herbs do not contain the active principles of tea and coffee. Among these beverages may be mentioned, sage tea, mountain tea (Gaultheria procumbens), Labrador tea (Ledum palustre), anise tea, sassafras tea, peppermint and spearmint tea, etc.

[1] Diet and Dietetics, Gautier, p. 273.
[2] Church, Foods, p. 220.

COFFEE (Coffea arabica)

The coffee tree is indigenous in southern Abyssina, and was very early cultivated in Arabia, and the East Indies The plant is also said to be indigenous in southern India, Liberia, Costa Rica and in various localities in South America, especially in Brazil.[1] As a beverage it has been traced back to the Persians who first used it in 875. Coffee was greatly prized by the Mohammedan priests, and was extensively used and sometimes prohibited by them, as a knowledge of its virtues was passed along from Persia westward to Cairo, Syria and Constantinople. The Dutch traders in the seventeenth century transported coffee from its original habitat in Arabia and Abyssinia to their colonies in Java, and Batavia, and began the cultivation of the plant, and introduced it into the West Indies in 1710. It was later introduced by the English into Jamaica, and by the French into Martinique. The extensive coffee plantations of most of these islands are the progeny of a single plant brought to Martinique in 1720 by a French officer. A Franciscan monk sent some coffee seeds to Brazil in 1774. There are several accounts of the introduction of coffee into England, but its first notice there was when used by a Cretan student in Oxford in 1641.[2] An English merchant is said to have set up his Greek servant in a coffee house in Cornhill (London) in 1652, and the same man opened a coffee house in Holland shortly after. The first coffee house was opened in Paris in 1671. The early English and Dutch immigrants introduced coffee into the United States, but it was regarded as a luxury in this country until the nineteenth century.

Cultivation of the Plant

The coffee berry grows on a small tree of which there are numerous species. In cultivation it is not allowed to grow more

[1] Coffee from Plantation to Cup, Thurber.
[2] Loc. cit., Tibbles.

than 8 to 12 feet in height, but the wild tree readily grows to a height of 20 feet or more.

The trees begin to bear when three to five years old and are productive from twenty to thirty years. They are raised from seeds planted in nurseries, and when eighteen months old, the plants are transferred to the plantations, where they are set 8 or

Fig. 73.—Coffee branch, with flowers and berries. (Thurber in "Coffee from the Plantation to the Cup.")

10 feet apart. The leaves are dark green and glossy, and the berries are borne at the base of the leaves. (Fig. 73.) The trees, which are evergreen, are pruned to a height of from 4 to 6 feet, so that the berries can be conveniently picked. Frequently only one seed is borne, and this is known as the "male" berry, "virgin," or pea berry. This is popularly supposed to be of finer quality

than the ordinary berry, but this is not necessarily the fact. Male berries may be found in any kind of coffee, and are usually picked out and sold at a better price than the ordinary berries. The berry is red when ripe, and looks somewhat like a long cranberry. In dissecting the berry we find that it is protected by an outer skin, beneath which is a soft pulp, and under this is a soft, sweet glutinous substance. Under this is a skin called the "parchment," lined with the "silver skin" which incloses the two beans lying face to face.

The picking of the berry begins in Java in January and lasts three or four months while in Brazil the pickers begin gathering in April and continue the work until September.

Preparation of Coffee for Market

The original method of "pulping" the coffee berry, and that still in use in Arabia and some parts of the East, is to dry the berries, on racks in the sun, and then remove the dried skin and pulp by passing the berries through a machine called a "huller" and which is run by hand or power. The primitive method used in Ceylon is to pound the berries in a mortar, in the same way that the hull is removed from the rice kernel. In Brazil the berries are put into a rough mill and are rolled around with cobble stones.

In the West Indies by the method of hulling, which is in more common use, the fresh berries are carried by a stream of water into a machine between a revolving iron cylinder set with teeth, and a curved sheet of metal. By this operation the pulp is loosened and carried away by the water and the beans sink to the bottom of the tank.

The berry, thus divested of its pulp, and known as the "parchment" berry, is soaked from twelve to fifty hours in water, where a kind of fermentation takes place which assists in the removal of the skin. This is called "washed" coffee, and is considered of better quality than that prepared by other methods. The berries are dried in the sun, or by artificial heat, and without further treatment, are sent to the place of shipment. Here they are again dried and passed between rollers to crack the outer envelope or skin, which is finally removed by winnowing.

Coffee Roasting

As with tea, a certain amount of firing is necessary to develop the flavor, so coffee requires roasting before it can be used to prepare the beverage.

Before roasting all the light material such as sticks, dust, and chaff is removed from the coffee, and after roasting the coffee is drawn upward by a current of air, leaving behind the heavy refuse such as small stones, pieces of iron, etc. Roasting may be carried on in a small way in the kitchen with each pound purchased, but it is much better and more uniformly done on a large scale by the professional coffee roaster. This process requires great skill for if not roasted sufficiently the product will lack aroma and flavor, and if the coffee is overroasted, it will be bitter and acrid. The ordinary method of treatment is in a rotary roaster over an open fire. The best temperature is not much above the boiling point of water, but as each coffee or mixture of berries requires different treatment, no definite directions can be given for the process, and it is often carried on at a much higher temperature. During this process from 12 to 20 per cent. of moisture and volatile matter is driven off. Organic matter, 10 per cent. of the fat, 21 per cent. of the caffein and other organic substances are lost during the operation, and caffeol is developed. Recently a method has been devised for saving and purifying the caffein which deposits in the flues above the coffee roaster. The average loss in weight of coffee by roasting is 16 per cent., and to this fact and the additional labor which is thus required, must be attributed the higher price of roasted coffee over that of the green berry. Ground coffee should always be packed in air-tight cans, so that the flavor may be retained.

Glazing Coffee

The glazing of coffee dates from the time of Liebig.[1] The process is intended to prevent the loss of aroma, and sometimes it is practised so as to add to the weight of the coffee. Leibig suggested the use of sugar, which if added while the berries are hot, glazes and protects them. Germany allows the use of sugar for this purpose to the amount of 4 per cent. and Belgium to the amount of 1 per cent.

Other glazes that have been used are graphite, charcoal, ultramarine, prussian blue, tannate of iron, lead chromate, talc, and especially rosin and shellac. These are made to stick to the berries by the use of butter, oil or gum. In some countries the use of resin and shellac glazes is allowed if its presence is declared by the manufacturer. Glazes are allowed if stated on label in the United States.[2]

Composition of Coffee

The analysis of coffee before and after roasting is given as follows by König:

	Raw	Roasted
Water	11.23	1.15
Caffein	1.21	1.24
Fat	12.27	14.48
Sugar	8.55	0.66
Cellulose	18.17	19.89
Nitrogenous substances	12.07	13.98
Non-nitrogenous matter	33.79	45.09
Ash	3.92	4.75

The amount of caffein in raw coffee varies in different kinds from 0.24 to 1.75 per cent. Roasting, if carefully done, does not appreciably modify it. This principle is identical with

[1] Z. Unters. N. u. Gen. 1899, Hanausek, p. 275.
[2] U. S. F. I. D., No. 80.

thein of tea, but is only one-third as abundant as in tea. It has the symbol $C_8H_{10}N_4O_2$. The fat is also an important constituent and varies from 4 to 12.6 per cent. In the "non-nitrogenous matter" is included caffeotannic acid and caffeic acid, and the volatile oil caffeol ($C_8H_{10}O_2$) which is developed on roasting, gives to coffee its characteristic aroma and flavor.

As a much greater weight of material is used in making coffee than in making tea, there is not a great deal of difference in the amount of caffein and tannin present in a cup of the two beverages. Coffee, however, contains more body than tea, on account of the presence of dextrin, sucrose and fat.

Preparation of the Beverage

With an understanding of what the constituents of coffee are, it is evident that in preparing the beverage, an effort is made to retain as much of the volatile oil, caffein, and nutritive constituents as possible and eliminate the tannin. There are at least three methods of making the beverage:

1. *Percolation*, a process in which boiling water is poured over and allowed to percolate through the finely ground coffee, thereby dissolving from 11 to 15 per cent. of the coffee instead of 20 per cent. obtainable by other methods. This is essentially the French method, and many patterns of coffee pots have been devised for this process. In France the grounds are often utilized by pouring hot water over them, drawing this off, and using it instead of water for the preparation of the next lot. Vienna coffee is made by a similar process, except that steam and hot water pass through the coffee, which is held in a strainer above the water. The drip coffee of the southern United States is made by packing the finely ground coffee in the top of a French coffee pot. A little boiling water is poured over this and percolates very slowly through the coffee, then a little more water is poured over it, repeating the operation every five minutes. This process gives a very strong decoction. Chicory (see p. 186) is often used in the French cafés to give body, bitterness and color to the

coffee. The black coffee, (*Cafe Noir*) of the French is made by the filtration method. *Cafe au lait* is made in the same way and served with hot milk, usually in the proportion of three parts of milk to one of coffee.

2. *Infusion* is the common method of making coffee in the United States and England. Freshly roasted and rather finely ground coffee is used in the proportion of 1 to 2 ounces to a pint of water. The water, which should not be too hard and freshly drawn, should be allowed to boil *tumultuously* for a moment or two only before it is poured over the coffee. The mixture may be allowed to boil for four or five minutes, and should then be served as soon as the grounds settle. If well-washed egg shells, or a little egg albumin be mixed with the coffee and a little cold water before the addition of boiling water, the settling and clarification of the beverage will be facilitated. If sugar or cream are used in the coffee they should be placed in the cup *before* the beverage is poured. In any case, a perfectly clean tin on aluminum coffee pot should be used, and the coffee poured off into a metallic, porcelain or earthenware vessel as soon as possible. A comparatively new tin coffee pot may be used, but an old tin coffee pot, from which considerable of the tin is worn off will injure the flavor of the beverage. Soft water extracts more of the constituents from the berries than does hard water.

3. The process of *decoction* is the one employed in making Turkish coffee. The requisite amount of the finely ground coffee is placed in a small coffee pot, cold water is poured upon it and it is heated to the boiling point. This is then immediately served without settling. The Turks swallow the grounds as well as the beverage; they never use milk or cream. Coffee made in this way is the common beverage throughout the East.

Physiological Action of Coffee

Coffee used as a beverage removes the sensation of fatigue in the muscles and increases their functional activity.[1] It allays

[1] Practical Dietetics, Thompson, p. 217.

hunger to a certain extent, and in some cases stimulates the heart action; it acts as a diuretic and often counteracts nervous exhaustion. If taken in moderation, it does not tend like tea to produce constipation, but has the opposite effect. Coffee would not be considered a food from a nutritive standpoint, although it has some effect in preventing tissue waste.

Coffee, also, has its evil effects. If strong coffee is taken after dinner, it tends to retard digestion for those who have dyspeptic tendencies. The continuance of the practice of drinking strong coffee to keep awake or to be able to do an extra amount of work, produces the "coffee habit," and the symptoms of nervousness, heartburn, dyspepsia, and insomnia follow. A cup of strong coffee in the morning soon becomes an absolute necessity before any work can be accomplished. The action of coffee as a whole upon the system, is quite different from the action of either of its principal constituents, that is the caffein, volatile oil or tannin separately.[1]

Varieties of Coffee

Brazil is by far the greatest coffee-growing country in the world. Venezuela and the Central American States stand next in rank as coffee producers. Since coffee is raised in so many different localities, under widely different climatic conditions, the varieties are necessarily numerous. To this must also be added the fact that the coffee in these countries may be from a different stock, and has been variously changed by cultivation.

Mocha coffee comes from Yemen a small district in Arabia where for more than 400 years it has been an important crop. It grows in an excessively hot region where shade and irrigation are indispensable.[2]

The excellence of this coffee is said to be due to the dryness of the climate, the granitic character of the soil, and to the fact that the coffee berries when ripe are never picked but are allowed to fall from the trees of their own accord, and to dry naturally, after

[1] For Toxicity of Caffein, see U. S. Dept. Agri. Bur. Chem., Bull. No. 148.
[2] Coffee from Plantation to Cup, Thurber.

which they are hulled by the simplest and most primitive methods. The bean is small, hard, round and symmetrical in form, of an olive green color which changes to a yellowish with age. The quantity of Mocha coffee actually exported at the present time is comparatively very small, but considerable so-called Mocha, grown in India, Brazil, Guatemala or Abyssinia finds its way into the market in the place of that grown in the district of Yemen.

Java coffee occupies a very high position in name at least, in the United States, although a large proportion of the coffee imported under that name is actually raised in the islands of Celebes and Sumatra. In the island of Java, the coffee is raised under the direction and control of the Dutch. Here at one time each family was obliged to care for 1000 coffee plants, under government superintendence, and from this system comes the term "Old Government Java." Java coffee is subjected to a drying process in covered "go-downs" and thus mellows by age. It is sometimes kept for four or five years before being placed on the market. The beans are larger than most coffee, and of a yellowish brown color.[1] Other East Indian varieties are the *Mysore*, *Neilgherry*, and *Coorg*. A comparatively small quantity of coffee is raised in Ceylon, and this is used principally for blending with other varieties.

The *Liberian* coffee first raised in the African Republic of that name, has attracted some attention but is not yet grown in large quantities. This variety of coffee is adapted to growing in hot, moist lowlands, and is also cultivated in Java and other coffee countries.

Some of the best-known coffees of the West Indies are *Jamaica*, *San Domingo*, *Hayti*, *Porto Rico* and *Cuba*. From the states of Nicaragua, Honduras, San Salvador, Guatemala and Costa Rica in Central America a large amount of coffee of various grades is exported. Venezuela, Colombia and Ecuador furnish at least 10 per cent. of the coffee received into the United States. These are especially known in the market as Maracaibo and Laguayra

[1] G. W. Smith, Ridenoue-Baker Gro. Co., Kansas City, Mo.

coffees, and are used in making blends with other varieties. The "Bogota" is a species of coffee transplanted from Java to the mountainous regions of Colombia. While possessing some of the characteristics of the true Java, it is less expensive. It is a large well-developed bluish-green bean, furnishing a deep chocolate brown beverage.

From *Colombia* a variety known as "*Bucaramangas*," or "Bucho" is also obtained. From Venezuela, comes the *Maracaibo*, of which there are five varieties. The natural bean is large, round, solid and of a deep rich yellow color. There are several varieties of coffee grown in Mexico, especially in the southern provinces. One of these the "*Oaxaca*" growing in the mountains furnishes a heavy, strong beverage and is useful for blending with other varieties. Another, the "*Cordovas*" which is quite well known, is grown in Vera Cruz, and is an unusually large yellowish bean.

More than half of the coffee supply of the world comes from Brazil. It comes from San Paulo, and is shipped under the name of "*Santos*," the port of the province, from Rio de Janeiro, and bears the name of "*Rio*," from Esparento Santo which produces "*Victoria*" and "*Bahia*," and from the province of *Minas Geros*, which is shipped under the name of "*Minas*."

The *Rio coffees* are heavy in body, and in "cup quality," are pungent with a "bitterish bite" or after-taste. Victorias and Bahias are not extensively used in the United States, while the Minas have the characteristics of both Rios and Santos coffees. Santos coffees are mild and fragrant "in the cup," entirely different from the rank quality of the Rios. They are used mostly for blending. A Bourbon Santos is a transplant of the Mocha plant to the Brazilian soil, and although it resembles the Mocha in many respects, it has not the bitter flavor of the latter.

Adulteration and Falsification

The substitutions and adulterations in the coffee trade are very numerous. It is a common practice to sift or pick the berries, selling one size as Mocha, another as Java, and another as Santos. By washing the Santos berries, decolorizing with lime water, and drying rapidly, slightly roasting and coloring with an orange dye,[1] they are made to pass as Java coffee.

The glazing of the coffee berry has already been referred to (p. 468). Whole coffee is not usually adulterated in any other way, although inferior grains by the glazing process are made to "appear of a better quality than they really are." It is interesting historically to notice that a few years ago there appeared on the American and German market many imitation coffee berries, molded from wheat flour, ground peas, sugar and other materials, which closely resembled the genuine coffee.[2]

It is in the roasted and ground coffee that the opportunity for adulteration exists, and of this great advantage is taken. Some of the common adulterants used are the roots of chicory, dandelion, beets, carrots, etc.; acorns, beans, peas, barley, malt, rye, date stones, as well as dried figs, locust beans, dried biscuits, mineral and organic coloring matters and pellets made from ground peas or cereals, molded and roasted. These substances are most readily detected by careful inspection and the use of the microscope.

Chicory (see p. 186) has been for so long a time used both as an adulterant of coffee, and as a constituent of imitation coffees and coffee substitutes that it deserves special notice. It is a sort of wild endive (Chicorium intybus) of the natural order *Compositæ* and bears a flower something like the dandelion in appearance. It is extensively grown in Germany, Italy, Holland and northern France. The roots are washed, sliced, dried and finally roasted with lard or some other fat. This root is entirely different in composition from coffee, for it does not contain any alkaloid or fragrant oil nor caffeotannic acid; all characteristic ingredients of coffee. Chicory contains inulin, instead of starch, also levulose, and dextrose, and after roasting 10 to 15 per cent. of caramel.

The coloring power of chicory is very great,[3] and this is the

[1] Bull. de Soc. Chim. d. Paris, Vol. 47, p. 7.
[2] U. S. Dept. Agri. Bur. Chem., Bull. No. 13, pt. 7.
[3] Grimshaw, Br. Food Jr., II, 3 (Chem. Abst., Vol. 3, p. 1193).

principal reason for its addition to coffee, as the use of a small quantity makes the infusion appear a dark brown, and apparently very strong. Digestion is more impeded by chicory than by coffee. The constant use of chicory as a beverage may cause injury to the system on account of the great quantity of potassium salts which it contains, and it exhibits no corresponding advantages in the way of stimulating and exhilarating effects on the system.

The sale of the cheap ground coffee is, however, not so much to be condemned on account of its effect on the system as because it is a fraud on the consumer, who often purchases a cheap article at an exorbitant price.

Of the 16,000,000 bags of coffee, of 120 pounds each, having a total value of over $200,000,000, produced annually in the world, Brazil frequently furnishes over 10,000,000 bags. The United States is the great coffee consumer of the world. The average consumption here is about 12 pounds per person each year, while that of Holland is 14 pounds, of Germany 6 pounds, and of Great Britain, Australia and Canada only 1 pound.

Coffee Substitutes

The materials already referred to which are used for adulteration of coffee are also used in making coffee substitutes. Some proprietary mixtures are on the market, which are made from bananas, roasted grains, low-grade molasses or "black strap" (see p. 115) and coloring matter. Dandelion is sometimes substituted for chicory, in making mixed coffees or is used directly for making a beverage. Gumbo or okra (see p. 173) figs and acorns are used in a similar way.

Coffee extracts are much in demand, especially in some parts of the Continent. They may be made by digesting coffee and chicory, and evaporating the infusion *in vacuo*. Some of these prepared coffees are made by evaporation of the coffee infusion alone. They have the advantage that the beverage is quickly prepared, as it is only necessary to dissolve the powder in hot water, but they usually lack the agreeable aroma of fresh coffee. A coffee extract, consisting essentially of chicory, is often added to genuine coffee to give it more color, and because the chicory flavor is by some persons considered agreeable.

Caffein-free Coffee

Since the claim is often made that the caffein of coffee is injurious to the system, many attempts have been made to introduce a so-called "caffein-free" coffee. This product instead of containing 1 to 1.2 per cent. of caffein, sometimes contains only 0.3 per cent. It is prepared by a process of carefully heating the berry, under special conditions.

COCOA AND CHOCOLATE

The *cacao* (Theobroma cacao) is a native of tropical America. The knowledge of this tree was first brought to Europe in 1519 by Fernando Cortez.[1] This was more than a hundred years before the use of coffee became common in Europe. Cortez found the tree growing in Mexico, where its cultivation had been carried on for several centuries. The Mexican name for the plant is "cacao" but the name "Theobroma" (food of the gods) was first applied to it by the botanist Linnaeus. The use of chocolate spread from Spain to Italy, where in 1606 the Florentine Carletti first made known to Europeans the method of converting the cacao beans into chocolate. A little later it was introduced into France, and by the middle of the seventeenth century chocolate houses were opened in England. Chocolate was first manufactured in the United States at Danvers, Massachusetts, in 1771.

Cultivation of the Tree

The cacao tree is grown over a large area, including Mexico, Central America, the West India Islands, the northern provinces

[1] The Manufacturer of Chocolate, Zipperer.

of South America, Brazil, Ecuador and Peru, and its cultivation has more recently also been extended to the Philippines, the East Indies and Ceylon.

A soft, moist, humous soil and a climate where the mean temperature is between 24° and 28° C. are the conditions best adapted to the growth of this tree. The cacao seeds may be sown in the field or the plants may be first started in a nursery, and transplanted to the plantation. When the tree grows wild in the forests it is found under the protecting shade of other trees, and

FIG. 74.— Cacao plant, showing flowers and fruit.

so, on the plantations, in imitation of this habit, the banana or coral tree is grown at the same time to afford a shelter to the cacao. The cacao tree comes into bearing after five or six years, and may continue to bear fruit for fifty years. It grows from 12 to 20 feet in height, with a trunk from 5 to 8 inches in diameter. The flowers and fruit are borne not only on the thicker branches, but also on the stem, and the crop is harvested throughout the entire year. (Fig. 74.)

The beans, as they are called, which are about the size of almonds, are arranged in five rows in the pulpy flesh of the pod. These pods are about 8 inches long and something like a cucumber in shape; although, tapering to the point at both ends, and corrugated along the sides.

Preparation of the Beans

There are several methods for treatment of the beans or kernels to prepare them for the market. The beans are removed from the shells, and subjected to a process of fermentation, either in boxes or holes in the ground. This process enables the pulp to be removed, and, probably by the action of an enzyme, changes the color and especially the chemical composition and flavor of the beans.

The next process is drying and roasting, which latter process further develops the flavor and removes the astringent taste and also enables the shells to be readily removed. These shells are the "cacao shells" of the shops from which a low-priced beverage can be made. They contain, however, very little of the cacao substance except the flavor. When the beans are cracked or crushed the germ or radical is also removed. The cracked or broken beans are called "cacao nibs," and from these also by protracted boiling a beverage can be made.

Manufacture of Cocoa and Chocolate

It seems desirable, in order to prepare a more wholesome and satisfactory beverage from the cacao beans, and to open up their tissues so as to render the materials more capable of emulsion and suspension in water or milk, that they should be subjected to some special treatment. Among the processes for the preparation of the so-called "soluble" cocoa, may be noticed the Dutch method, which is either with or without the removal of some of the fat, to treat the powder from the roasted beans with some alkali as potassium or sodium carbonate, and the German method in which ammonia or ammonium carbonate is used.[1] Treatment

[1] Loc. cit., p. 179.

with alkali is regarded by some with disfavor and as wholly unnecessary.[1]

The fat is extracted by pressing the powder, packed in cloth bags, in a hydraulic press, at about the temperature of boiling water. The quality of the fat, which is run into molds and sold as "cocoa butter," is better and the grade of the remaining cocoa is also higher if as much as 30 per cent. of the fat present is allowed to remain in the powder. Zipperer[2] believes that the treatment of powdered cocoa from which the fat has been expressed, with a *volatile* alkali, is the best method of rendering cocoa soluble. The Dept. of Agri., however, consider the term "soluble" as applied to this process a misnomer, as no more cocoa is made soluble than by any other process.

In the manufacture of plain or "bitter" chocolate, the beans, which been have previously roasted and shelled, are ground while warm to a pasty mass in a suitable machine. If "sweet chocolate" is to be made, this cacao mass is then incorporated with sugar, spices, and other flavoring material, by grinding in a mill so arranged that the mixture can be heated to a temperature of 35° to 40° C., a temperature which is rather above the melting point of the cacao butter. The flavoring material may be cinnamon, clove, cardamon, mace, oil of lemon, or vanilla. The variation of the proportion of sugar and the different flavoring substances, constitutes the chief difference between various kinds of chocolate. Frequently a considerable amount of the fat is removed from the ground beans by pressure, before the chocolate is made. If more than 60 per cent. of sugar is used, cacao butter must be added to produce a mass that can be molded. The cheaper chocolates are those containing the largest per cent. of sugar.

Chemical Composition

The principal constituents of the raw cocoa beans are fat, proteins, starch, theobromine, tannin, and ash.

[1] Food Inspection and Analysis, Leach, p. 305.
[2] Loc. cit., p. 199.

The following is the analysis of some cocoa products:[1]

	Pure cocoa	Cocoa shells	Plain chocolate	Sweet chocolate
Water	6.23	4.87	3.78	2.17
Ash	5.49	10.43	3.15	2.17
Theobromine	1.15	0.49	0.78	0.35
Caffein	0.16	0.16	0.13	0.08
Other nitrogenous substances (protein)	18.34	14.46	12.36	4.58
Crude fiber	4.48	16.55	2.86	0.95
Sugar	0.00	0.00	0.00	56.44
Pure starch	11.14	4.13	8.11	2.88
Other nitrogen-free substances	26.32	46.15	16.64	7.64
Fat	26.69	2.76	52.19	23.51
	100.00	100.00	100.00	100.00

The *fat*, which forms from 36 to 55 per cent. of the bean is a mixture of the glycerides of stearic, palmitic, lauric and arachidic acids (see p. 307), and under the name of "cocoa butter" melting at 86° to 95° F. is of great value in making pharmaceutical preparations.

Theobromine, which was discovered in 1841, is an active principle, having the composition ($C_5H_2(CH_3)_2N_4O_2$), a dimethylxanthine. Caffein, the active principle of coffee, is a trimethylxanthine ($C_5H(CH_3)_3N_4O_2$). Theobromine occurs in amount from 1.0 to 2.65 per cent. About half of the nitrogen found in cacao is believed to be amide nitrogen, and consequently not available as a nutrient. The starch adds somewhat to the nutritive value of this product. During the process of roasting it is believed that a peculiar volatile flavoring substance or oil similar to the caffeol of coffee, is developed. Although some of the *tannin*, which exists in the raw bean, is rapidly oxidized to a "cocoa-red" to which

[1] Ct. Ag. Ex. Sta. 1903, Pt. II, p. 125.

the color of cocoa is due, the roasted beans still contain 4 to 5 per cent. of this astringent substance.

Physiological Action of Cocoa Products

While tea and coffee have only slight food values, cocoa and chocolate in addition to their stimulating properties should be regarded as real foods. The action of cocoa on the nervous system is much less than that of tea or coffee, and it has a less stimulating but more sustaining effect. The stimulating effect of some of the cocoas on the market has been increased by the addition of Kola, a practice that should be discouraged. Cocoa is a valuable beverage for the use of invalids, unless the amount of fat which it contains interferes with the digestion. Chocolate is usually more liable to produce indigestion than cocoa. It has been used as a part of army rations and appears to be very satisfactory as a slightly stimulating and nutritious food.

Falsifications and Adulterations

Cocoa is frequently adulterated with sugar and various starches. Cocoa shells are sometimes ground and added to the product, and mineral coloring matter is occasionally found. It is understood that the removal of some of the fat is permissible, but it should contain no *added substances*.

Plain chocolate, according to the United States Standard contains not less than 45 per cent. of cocoa fat, and if fat has been abstracted, this constitutes adulteration. An excess of sugar in the sweet chocolate, or added starch, mineral or anilin coloring matters constitute adulteration.

The use of varnishes to protect the surface of chocolate candy has been investigated by the United States Department of Agriculture, and only an edible gum should be used. (See p. 130.)

Use in Different Countries

The United States ranks first in the list of cocoa-consuming countries followed by Germany, France, England, Netherlands, Switzerland and Spain in the order named. Over 156,000,000 pounds was imported into this country in 1912. Of the 551,000,000 pounds of cocoa produced in 1911, the largest amount came from San Thome and Principe,[1] Ecuador, Brazil, Trinidad, Gold Coast, Dominican Republic and Venezuela. The amount consumed in the entire world annually is increasing very rapidly.

MATÉ, KHAT, KOLA, GUARANA, COCA

Maté or Paraguay tea, a beverage made from the leaves of a species of holly (Ilex Paraguayensis) growing abundantly in Paraguay, Brazil and other South American countries, is very commonly used by the natives. The leaves are dried and slightly roasted, and contain from 0.5 to 1.8 per cent. of thein and an essential oil and afford a somewhat bitter, aromatic and astringent beverage. The natives prepare the tea in a gourd and drink it by drawing it through a tube often of silver perforated at the end, called a bombilla. The production of maté is said to be more than 8,000,000 pounds per year.

Khat, a tea that has been used in Arabia from the earliest times, consists of the leaves of the shrub *Catha edulis*, which grows wild in Abyssinia and is cultivated in Arabia.[2] The leaves of the plant are dried and used for making a decoction which contains an active principle called katin, having stimulating properties similar to caffein.

The **kola** nut is the fruit of the *Sterculia acuminata*, a tall tree growing in Jamaica, on the west cost of Africa, in East India, Ceylon and Brazil. The active principle, called kolanin, is developed by fermentation in the process of curing and under the influence of an enzyme, is broken down into kola-red, caffein and tannin. The beverage is made by boiling the powdered nut with water for five minutes. Kola has the property of increasing the number and energy of muscular contractions, preventing fatigue and rendering the respirations more free. It is mildly stimulating

[1] Dept. Commerce and Labor, Spec. Consular Rep. No. 50.
[2] Loc. cit., Tibbles.

to the heart and nervous system. Opinions are divided as to whether its secondary effects are as injurious as many other narcotics. As a substitute for food on long or forced marches, kola is said to sustain the strength for a longer time and serve better than tea or coffee.[1]

Guarana is a preparation made in Brazil and other South American countries from the crushed seeds of the *Paullinia Cupana.* It contains from 3.5 per cent. to 5 per cent. of alkaloidal substances mostly caffein, besides tannin, sugar and a volatile oil. The product comes into the market in long sausage-like rolls, from which pieces are broken and infused in cold water to make a refreshing beverage. Guarana acts as a stimulating beverage and enables the traveler to resist hunger and fatigue during long marches.

Coca is made from the leaves of the enythroxylen coca which grows in Bolivia, Peru and other parts of South America. The natives chew the leaves. The annual consumption is said to be 100,000,000 pounds. The stimulating effect of coca is due to the presence of cocaine ($C_{17}H_{21}NO_4$), ecgonin, and some aromatic substances. It produces some excitation, and causes the sensation of hunger to disappear. It also allows fatigue to be borne for a time without recourse to food.[2] It is less exciting than either tea or coffee, but has a more pronounced action on the heart. The effect of the continued use of cocaine on the system is extremely bad, and the cocaine habit like the morphine habit is very difficult to overcome. (See p. 496.)

[1] Practical Dietetics, Thompson, p. 225.
[2] Diet and Dietetics, Gautier, p. 277.

CHAPTER XX

WATER AND EFFERVESCING BEVERAGES

("Soft Drinks")

Water as an indispensable constituent of foods has already been discussed. The amount of water in foods is always surprising. Upon analysis the vegetables and fruits are found to contain from 70 to 90 per cent. of water. Asparagus, celery, lettuce, pumpkins, cucumbers and melons are all high in water and correspondingly low in food material. The cereals, and legumes, and such tubers as potatoes contain large quantities of water, but not so much as fruits. Fish, meat and game contain from 60 to 80 per cent. of water. As there is a tendency to use an insufficient amount of water or other liquids with the daily diet, this quantity of water in the foods assists very much in keeping up the fluidity of the food mass as it passes through the body. Recent investigations seem to indicate that water and other liquids taken in quite large quantities with the food tend to assist digestion rather than retard it, as was formerly taught. The presence of water in foods is one of the factors which tends to hasten fermentation or decomposition, and hence the universal practice, at a very early age in the development of the race, of drying foods to preserve them.

WATER AS A BEVERAGE

Water is the basis of all beverages, and constitutes a very large percentage of all those known even by other names. Most of them are simply water flavored with alcohol, vegetable extracts, sugar, acids and fruit ethers, holding in solution alkaloids or proximate vegetable substances, and often surcharged with carbon dioxide gas. Potable waters, or those that are suitable to use as a source of domestic supply and for drinking, may be derived from *public* or *private* sources. The advantage of a public supply is that the whole quantity used by the city may be supervised carefully and analyzed frequently, thus insuring its purity as a supply. If the water is drawn from numerous wells, springs and cisterns, it is liable in each individual case to be contaminated. On isolated farms or in smaller villages there are always sources of filth near at hand in stables, closets, drains, cess-pools or hog wallows. Few persons appreciate how readily surface water may find its way from this source of filth to the source of the water supply. It may percolate through the soil without any sensible purification, or it may run over the surface and run into the well or cistern, carrying with it any germs of disease that may have been in the filth with which it came in contact. Because a water is clear, colorless and tasteless it is often considered safe, while the fact remains that some of the most dangerous waters do not betray their character by their taste, color or appearance.

SOURCES OF SUPPLY

Domestic supplies may be obtained from a spring, brook, river, pond or lake, or from a shallow (dug) well, a driven well or an artesian well. The rain water may also be collected from the roof, and stored in a cistern or reservoir.

Impurities in Water

The substances contained in water are of two general classes, mineral and organic.

As water percolates through the soil and over the rocks it dissolves various mineral substances. This solution in water is aided by the carbon dioxide and other gases that are dissolved in the water, and the rocks are disintegrated by changes of temperature and frost. The mineral substances ordinarily found in water include calcium, magnesium, sodium, potassium, iron, aluminum and a few other metals united with such acid ions as chlorine, sulfur, and the sulfate, carbonate, nitrate, phosphate, and silicate ions.

Hard and Soft Water

When there is considerable calcium or magnesium salts in the water it is known as a hard water. If this is in the form of carbonate the water is said to be "temporarily hard," while if in the form of sulfates the water is "permanently hard." Chlorides and sulfates of sodium, iron, etc., are also found in permanently hard waters. Much of the calcium and magnesium present in a temporarily hard water is precipitated by boiling, as it is held in solution by the excess of carbon dioxide which is removed by boiling. This accounts for most of the incrustation on the bottom of a tea-kettle or other vessel in which hard water is boiled. If the mineral substances are not too abundant they are not considered particularly injurious. For some culinary purposes, hard water is not satisfactory. For making tea, however, a moderately hard water is preferred. For laundry purposes hard water is very unsatisfactory, as the soap which is added is first used up in precipitating a lime or magnesia soap, before a permanent lather will form. When large amounts of water are prescribed for drinking, the water should be as soft as possible. The diuretic action of large quantities of water is well established. If an abundance of water is taken into the system the tempeature of the body falls and the number of pulsations of the heart and of the inspirations is diminished.

Table Waters

Many of the so-called "table waters" are comparatively free from mineral matter. In the Appalachian and Green Mountain regions of the United States where the rocks are of granite, trap or sandstone, and where there is very little soil through which the water can percolate, some of the purest natural waters are found. Thus, Paradise Spring at Brunswick, Me., contains only 0.99 grains of mineral matter per gallon; Poland Spring (Me.), contains 3.76 grains; Tunbridge wells (England), 7.61 grains, these are all very low in mineral substances.

Mineral Waters

Mineral waters belong to a different class from potable waters, in that they are used for their medicinal effect. They contain either large quantities of some ordinary mineral ingredients or small quantities of some ingredients which are rare and are supposed to have some special therapeutic value.

Organic Constituents

The organic constituents of waters are obtained from organic matter or that which is a product of cell life, and are either of vegetable or animal origin. These constituents, especially those of vegetable origin, may or may not be specially indicative of injurious substances, but they are of great importance to the physician, because they give some information as to the origin of the water and its history. When water is loaded with organic matter it is liable to contain the germs of disease. For instance, the water may have been mixed with drainage from a cess-pool, and may contain the germs of typhoid fever, cholera or some disease of that class. The presence of this organic matter is a warning to the chemist and the bacteriologist that the water is of a suspicious character; its source is carefully studied, and unless there is no possible opportunity for pollution the water is condemned. The bacteriologist at the same time makes cultures from a sample to ascertain if any organisms belonging to the disease producing class are present. It should be noted that these germs may be destroyed, and the water rendered safe for domestic use, by boiling for a short time.

To guard against impurities consisting largely of organic matter, the source of the supply should be carefully inspected. If a well, there should be no vault, drain, closet, stable or other source of filth in the vicinity; surface drainage should be fully eliminated by carefully protecting the ground around the well curb by cement or other impervious material. It should not be forgotten that a well is but a "hole in the ground," and as such all near-by filth will be washed into it or percolate through the soil until it reaches this lowest level. When ponds, lakes or rivers are used as a source of public supply the character of the water is at the present time carefully tested under the direction of the State or Municipal Boards of Health.

Cistern Water

Cistern water of good quality and safe for domestic use may be obtained in the country and in small towns, from a slate, metallic or well-painted shingle roof, if the first water of a rain is allowed to waste, so as to thoroughly wash off the roof. The water may be filtered through brick or through sand and charcoal, but this filtration should be made as the *water is drawn out of the cistern*, and not as it runs in, as water cannot ordinarily be filtered as rapidly as it falls from the roof. The quality of the water may also be improved by the use of some kind of an aerating pump which carries air into the water whenever water is removed from the cistern.

Use of Domestic Filters

It is a well-known practice to treat an impure water on a large scale with alum or with alum and iron, and filter it through sand, thus rendering the water safe for domestic use. This process cannot however be conveniently applied on a scale small enough for household purposes. Many of the filters recommended by dealers for domestic use simply strain out the coarser impurities, and are of no value to remove disease germs and thus render the water safe. There are on the market filters of the Pasteur type, made from unglazed porcelain or similar material, which practically remove all injurious organisms; these however necessarily filter the water very slowly.

Distilled Water

This is often used for drinking purposes, and has the advantage of always being a safe water, although it is by many considered very unpalatable. Distilled water owes its "flat" taste to the absence of dissolved gases which are found in natural waters, and to the absence of the mineral matter to which we have become accustomed. This water may be aerated, and thus rendered more palatable, by being allowed to stand for some time, or this may be done on a large scale by pumping air through the water.

This water is put on the market in many of the larger cities under various trade names. Sometimes it is recommended to add to the distilled water a few grains per gallon of potassium or sodium chloride; to improve its taste.

ICE

Foods and beverages are cooled and also preserved by placing them in cold-storage warehouses, or by keeping them in proximity to ice. A building, whose walls are constructed of non-conducting materials, is cooled by passing through it, often near the ceiling of the room, a set of pipes through which cooled brine is circulated. Boats used for the transportation of provisions are often cooled in the same way. At the present time, in all temperate or warm climates, the ice plant is indispensable for use in packing houses, and for all who handle meats, fish, eggs fruits or vegetables on a large scale. Cars and portable refrigerators are cooled by the use of blocks of ice.

For domestic and commercial use ice is either natural—that is, the product cut from the surface of lakes or rivers in the winter —or artificial. For making artificial ice, advantage is taken of the fact that liquid ammonia (NH_3), when it is allowed to expand to a gas, absorbs heat from surrounding objects and thus loweres their temperature. On this account as the liquid ammonia expands in pipes running through a tank of brine, the latter is cooled even below the freezing point of fresh water, so that water placed in metallic boxes and allowed to stand in the brine will after some hours be frozen to a solid cake of ice.

It is a mistake to suppose that because freezing or crystallization is a purifying process, ice made from impure water will be pure and safe for domestic use. A slight purification does no doubt take place, but the water obtained by the melting of such ice is somewhat dangerous. In any case it is a much better practice, in the cooling of water or other beverages to surround the vessel containing the beverage with ice rather than put the ice directly into the liquid.

Artificial ice since it is usually made from distilled water, has the advantage of being free from organic matter that may accompany germs of disease, and so be dangerous to health. There is a growing tendency among dealers to supply their customers with artificial ice rather than natural, even in those countries where a natural ice can be cut and stored in sufficient quantities in the winter.

NATURAL MINERAL WATERS

In some localities a natural mineral water, either slightly or heavily loaded with mineral salts, is bottled directly at the spring and put upon the market. Thus a general demand has arisen for such natural waters as Apollinaris, Vichy, Seltzer, Poland Spring. and the Saratoga waters. Sometimes the carbon dioxide which is given off from the water as it comes from the ground is pumped off, compressed and later used for charging the water when bottling. Very often carbon dioxide from other sources is used to carbonate the water. Some of these waters are alkaline and some simply saline-gaseous. The sparkling appearance and agreeable taste of these carbonated waters leads to their being freely used both directly and as a diluent for other beverages. There is no doubt that such waters stimulate digestion and promote greater activity in the alimentary canal. Where natural mineral waters containing large quantities of mineral salts, which have been bottled directly at the springs without any addition or loss of ingredients are used, it should only be under the advice of a physician. These ingredients may or may not be conducive to the health of the patient. Imitations of natural waters made artificially, and mixtures of salts with directions to dissolve in water, have, in great variety, been placed on the market. In 1912, 62,281,801 gallons of mineral water were produced in the United States, and 3,500,000 were imported.

FLAVORED CARBONATED WATERS—

SODA WATER

On account of the agreeable taste of carbonated waters, the attempt was made, more than two centuries ago, to produce them artificially. In some of the earlier attempts, acid and alkaline powders were mixed, as in Seidlitz powders. Somewhat later machines were constructed to generate carbon dioxide gas, and have it absorbed in water under pressure. Cold water under normal pressure absorbs or dissolves about its own bulk of carbon dioxide gas. Under a pressure of two atmospheres, water will absorb twice its bulk of the gas; a larger amount being absorbed under greater pressure. The gas was generated by the action of sulfuric acid (oil of vitriol), upon marble or chalk, and the gas was washed and passed directly, with constant stirring, and still under great pressure, into the water. The whole apparatus was strongly built to withstand the great pressure of the liberated gas. Carbonated water, prepared in this way may then be drawn into strong bottles, which previously contain some flavored and sweetened sirup, and thus soda water or "pop" is made. A very ingenious machine has been constructed for filling the bottles with the carbonated water. It is so arranged that the liquid is passed in and the cork or cap is put in place without the loss of pressure of the gas. A pressure of 120 to 140 pounds per square inch is sometimes used in bottling.

Manufacture of Carbon Dioxide

Carbon dioxide, which is obtained by burning some form of carbon, as coke or charcoal, or as a by-product in the manufacture of lime from limestone; thus $CaCO_3$ heated $= CaO + CO_2$, is at present used extensively instead of the gas made from the action of sulfuric acid on limestone. Another commercial source of carbon dioxide is the waste gas from the vats of the brewers. This is pumped off, washed and purified, and condensed in cylinders for use. Both in Germany and in the United States most of the carbon dioxide used by the smaller manufacturer of soda water, is liquefied in strong steel cylinders at a pressure of 1800 pounds per square inch, by compression pumps, and is sold to customers by the pound. This is an extremely convenient method of handling the gas as it can be kept in the cylinders until used. To dispense "soda water" it is only necessary to attach this cylinder to a strong vessel containing cold water, and allow the gas to saturate the water under pressure. This carbonated water is then drawn off at the "fountain," into any sirup of the desired flavor.

It has repeatedly been maintained that the pressure given to the water in the manufacture of soda water and pop, would destroy any pathogenic germs that might be present, and so the manufacturer would be justified in using an impure water for this purpose. On the contrary, it has been shown by experiments made by C. C. Young,[1] that this is not the case; distilled water or a safe water is just as necessary in making soda water as for any other beverages.

[1] J. Ind. and Eng. Ch., July, 1911.

Flavoring Sirups

For flavoring "soda water" as it is called in the United States, a natural or an artificial fruit sirup is used. In order to make the natural fruit sirup, the juice of the fruit, after being expressed, is mixed with sugar and pasteurized or sometimes boiled. The pasteurized fruit juices, if made carefully, and stored in a cool place, will keep satisfactorily. In case pasteurization is omitted, such preservatives as benzoic or salicylic acid are employed. There seems to be little need for the use of any preservatives in products of this class.

For making artificial beverages such as lemonade, orangeade, raspberryade, etc., acidulated sirups, flavored with ethereal essences or extracts, are often used. The acid selected is either tartaric, citric, phosphiric or acetic, and it should correspond to that in the fruit imitated, and should not be replaced by a cheaper acid. As all fruit owes its flavor to the presence of certain acids and delicate volatile ethers and aldehydes, mixtures of these substances prepared in the laboratory are frequently used to make the artificial fruit essence. It would be practically impossible to extract and isolate these compounds from the fruits, so imitations are made and put on the market under such names as "oil of apple," which is mostly valerianate of amyl; oil of pineapple, mostly butyrate of ethyl; oil of quince, mostly perlargonate of ethyl. These essences have an aroma and flavor which "suggest" the natural product, but they lack the delicate flavor which belongs to the fruit.

As an illustration of the methods of mixing the various chemicals to make the "Fruit Essences," the following table by Kletzensky[1] is given.

The numerals indicate the volumes of the materials to be used, and to this amount alcohol is to be added to make one hundred parts.

[1] U. S. Dispensatory, Nineteenth Ed., p. 1497.

	Chloroform	Nitrous ether	Aldehyde	Acetic ether	Formic ether	Butyric ether	Valerianic ether	Benzoic ether	Oenanthylic ether	Oil of persicot	Sebacic ether	Methyl-salycylic ether	Amyl alcohol
Pineapple	1	...	1	...	...	5	...	...	...	...	...	...	...
Melon	...	...	2	...	1	4	5	...	...	...	10	...	...
Strawberry	...	1	...	5	1	5	...	...	...	...	...	1	...
Raspberry	...	1	1	5	1	1	...	1	1	...	1	1	...
Gooseberry	...	...	1	5	...	...	...	1	1	...	...	...	...
Grape	2	...	2	...	2	...	...	...	10	...	...	1	...
Apple	1	1	2	1	...	...	...	...	...	...	...	...	...
Orange	2	...	2	5	1	1	...	1	...	...	...	1	...
Pear	...	...	...	5	...	...	...	...	...	...	...	...	...
Lemon	1	1	2	10	...	...	...	...	...	...	...	...	...
Black cherry	...	...	...	10	...	...	...	5	...	2	...	...	...
Cherry	...	...	...	5	...	...	...	5	1	...	...	...	...
Plum	...	...	5	5	1	2	...	...	...	4	...	...	...
Apricot	1	...	...	...	...	10	5	...	1	...	...	...	2
Peach	...	...	2	5	5	5	5	...	...	5	1	...	2
Currant	...	...	1	5	...	...	...	1	1	...	...	...	...

	Amyl-acetic ether	Amyl-butyric ether	Amyl-valerianic ether	Oil of lemon	Oil of orange	Saturated alcoholic solutions of				Glycerine
						Tartaric acid	Oxalic acid	Succinic acid	Benzoic acid	
Pineapple	...	10	...	...	...	...	...	...	...	3
Melon	...	...	...	...	...	...	...	...	...	3
Strawberry	3	2	...	...	...	...	...	...	...	2
Raspberry	1	1	...	...	...	5	...	1	...	4
Gooseberry	...	...	...	...	...	5	...	1	1	...
Grape	...	...	...	...	...	5	...	3	...	10
Apple	...	...	10	...	...	...	1	...	...	4
Orange	1	...	...	...	10	1	...	...	...	10
Pear	2	...	...	...	...	...	...	...	...	2
Lemon	...	...	...	10	...	10	...	1	...	5
Black cherry	...	...	...	...	...	...	1	...	2	...
Cherry	...	...	...	...	...	...	...	...	1	3
Plum	...	...	...	...	...	...	...	...	...	8
Apricot	...	1	...	...	...	1	...	...	...	4
Peach	...	...	...	...	...	...	...	...	...	5
Currant	...	...	...	...	...	5	...	1	1	...

While the "synthetic flavors," as they are called, cannot be considered as unwholesome when used in beverages, extracts or food products, the consumer should be notified by a distinct label on the package in case imitation flavors are used. The same remark applies to the artificial coloring matter, which is most frequently a coal-tar derivative. When soda water sirups are artificially colored, this should be plainly stated on the label.

Ordinary cane sugar is generally used to sweeten the sirups. The use of saccharin (p. 44) in the place of sugar, because it was cheaper, was formerly a very common practice in the United States. The strict enforcement of the Food Laws has caused this practice to cease, in many localities.

A genuine ginger ale should be simply carbonated water flavored with a sweetened extract of ginger. In actual practice much of the "extract of ginger" used for this purpose is "fortified" with capsicum, to give it greater apparent strength, because there seems to be a demand for this. It is colored with a yellow anilin dye, to make it more pleasing to the eye.

In order to produce a foam in these carbonated beverages, some vegetable preparation like soap-bark, containing "saponin," is used.

Fruit Vinegars

Fruit vinegars are made especially from raspberries, strawberries and blackberries. They may be made by heating together the fruit, sugar and vinegar, straining, sterilizing and finally putting away in sterilized bottles. A tablespoonful added to a glass of water makes an extremely agreeable and wholesome beverage.

Root and Herb Beers.—Various beverages containing but little alcohol are made by flavoring a sweetened solution, with some essence, bark-extract or herb, adding yeast, and allowing the solution to ferment. This may be put away in bottles with the cork securely fastened. In a few days, dependent on the temperature of storage, the beverage is ready for use. According to the English

Law such beverages should not contain over 1 per cent. of alcohol. In the United States any beverage containing over one-half of one per cent. of absolute alcohol is taxable.

Among the flavoring material used are decoctions of hops, nettles, ginger, spruce branches, sassafras, sarsaparilla, birch bark, tartaric acid and lime juice. These beverages are often called "small beer," and belong to the class of "soft" or non-alcoholic drinks. They are frequently named from the principal flavoring substance present. A market has also arisen for various "proprietary" flavors, which are put on the market as " . . . . . .'s root beer," with directions giving the proportions of water, sugar, yeast, and the "flavor" which is required in making the beverage.

Habit Producing Beverages

Coco-cola is the name of a proprietary beverage in common use in the United States. It was formerly believed by many that cocaine (from the cola nut or leaf) was one of the constituents, but this is not the case. Besides flavoring material the principal constituent of importance is caffeine. (See p. 468.) Comparing this beverage with others containing caffeine, J. W. Mallet says, that of caffeine, tea per cup ordinarily contains 2.02 grains; coffee, per cup, 1.74 grains; coca-cola, as ordinarily dispensed, contains 1.21 grains per glass. In regard to the properties of caffeine and the effect on man, Hollingsworth,[1] says: "Small doses of caffeine alkaloid (1 to 4 grains) taken in either pure form or accompanied by small amounts of sirup, do not produce appreciable sleep disturbance except in individual cases. Doses larger than these (6 grains in these experiments) induced marked sleep impairment with some subjects, even though here a few individuals show complete resistance to its effects. The effects are greater when the dose is taken on an empty stomach, or without food, and when it is taken on successive days so as to permit of accumulative effect. The effect of the drug does not seem to depend on age, sex or

[1] The Psychological Review, Jan., 1912.

previous caffeine habits of the individual, but varies inversely with the body weight. The conclusions hold both for the quality and the amount of sleep."

There is danger of excess in the use of any "habit producing," beverage, as overstimulation leads ultimately to serious, nervous conditions and impaired health.

APPENDIX

TABLE I

Reference has already been made to the use of the "Calorie" (p. 23) as a unit of energy. Since it may be found convenient in the calculation of Dietaries to have the percentage composition and fuel value or calories of the common foods grouped together for reference, the following tables from various Bulletins of the Department of Agriculture are here appended. The most convenient method of calculation is to determine how many calories a given weight will furnish. The latest determinations show that one gram of dry protein will furnish 4.1 calories; a gram of a carbohydrate 4.1 calories; and a gram of fat 9.3 calories. The percentages of the different nutrients in the tables which follow are multiplied by the figures given above, and the results added give the calories in a hundred grams of the food.

COMPOSITION OF GREEN VEGETABLES

	Water	Nitrogenous matter	Fat	Carbohydrates	Mineral matter	Cellulose	Fuel value per pound, calories
Cabbage	89.6	1.80	0.40	5.8	1.30	1.10	165
Cabbage, cooked	97.4	0.60	0.10	0.4	0.13	1.30	....
Cauliflower	90.7	2.20	0.40	4.7	0.80	1.20	175
Sea-kale	93.3	1.40	......	3.8	0.60	0.90	....
Sea-kale, cooked	97.9	0.40	0.07	0.3	0.20	1.10	....
Spinach	90.6	2.50	0.50	3.8	1.70	0.90	120
Vegetable marrow	94.8	0.06	0.20	2.6	0.50	1.30	....
Vegetable marrow, cooked	99.2	0.09	0.04	0.2	0.05	0.37	....
Brussels sprouts	93.7	1.50	0.10	3.4	1.30	......	95
Tomatoes	91.9	1.30	0.20	5.0	0.70	1.10	105
Tomatoes, cooked	94.0	1.00	0.20	0.1	0.70	1.50	....
Greens	82.9	3.80	0.90	8.9	3.50	......	275
Lettuce	94.1	1.40	0.40	2.6	1.00	0.50	105
Lettuce, cooked	97.2	0.50	0.16	0.5	0.40	0.90	....
Leeks	91.8	1.20	0.50	5.8	0.70	......	150
Celery	93.4	1.40	0.10	3.3	0.90	0.90	85
Celery, cooked	97.0	0.30	0.06	0.8	0.50	1.00	....
Turnip cabbage	87.1	2.60	0.20	7.1	1.50	1.30	145
Rhubarb	94.6	0.70	0.70	2.3	0.60	1.10	105
Macedoine (thinned)	93.1	1.40	......	4.5	1.00	......	110
Water-cress	93.1	0.70	0.50	3.7	1.30	0.10	....
Cucumber	95.9	0.80	0.10	2.1	0.40	0.50	70
Cucumber, cooked	97.4	0.50	0.02	0.7	0.20	0.90	....
Asparagus	91.7	2.20	0.20	2.9	0.90	2.10	110
Salsify, cooked	87.2	1.20	0.08	9.0	0.30	2.20	....
Endive	94.0	1.00	......	3.0	0.80	0.60	....
Savoys	87.0	3.30	0.70	6.0	1.60	1.20	....
Red cabbage	90.0	1.80	0.19	5.8	0.70	1.20	....
Sauer-kraut	91.0	1.40	0.70	2.9	1.70	0.90	....

COMPOSITION OF FRESH AND DRIED LEGUMES COMPARED WITH THAT OF OTHER FOODS

Material	Water	Protein	Fat	Carbo-hydrates	Ash	Fuel value per pound
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Calories
Fresh legumes:						
String beans	89.2	2.3	0.3	7.4	0.8	195
Whole pods of *Dolichos sesquipedalis*	79.9	4.5	0.5	13.9	1.2	365
Sugar peas or string peas	81.8	3.4	0.4	13.7	0.7	335
Shelled kidney beans	58.9	9.4	0.6	29.1	2.0	740
Shelled lima beans	68.5	7.1	0.7	22.0	1.7	570
Shelled peas	74.6	7.0	0.5	16.9	1.0	465
Shelled cow peas	65.9	9.4	0.6	22.7	1.4	620
Canned string beans	93.7	1.1	0.1	3.8	1.3	95
Canned lima beans	79.5	4.0	0.3	14.6	1.6	360
Canned kidney beans	72.7	7.0	0.2	18.5	1.6	480
Canned peas	85.3	3.6	0.2	9.8	1.1	255
Canned baked beans	68.9	6.9	2.5	19.6	2.1	600
Peanut butter	2.1	29.3	46.5	17.1	5.0	2825
Dried legumes:						
Lima beans	10.4	18.1	1.5	65.9	4.1	1625
Navy beans	12.6	22.5	1.8	59.6	3.5	1605
Frijoles	7.5	21.9	1.3	65.1	4.2	1695
Lentils	8.4	25.7	1.0	59.2	5.7	1620
Dried peas	9.5	24.6	1.0	62.0	2.9	1655
Cow peas	13.0	21.4	1.4	60.8	3.4	1590
Soy beans	10.8	34.0	16.8	33.7	4.7	1970
Chick-pea	14.8	12.4	6.7	63.3	2.8	1690
Peanuts	9.2	25.8	38.6	24.4	2.0	2560
St. John's bread (carob bean)	15.0	5.9	1.3	75.3	2.5	1565

COMPOSITION OF FRUITS

	Water	Protein	Ether extract	Carbo-hydrates	Ash	Cellu-lose	Acids
Apples	82.5	0.4	0.5	12.5	0.4	2.7	1.0
Apples, dried	36.2	1.4	3.0	49.1	1.8	4.9	3.6
Pears	83.9	0.4	0.6	11.5	0.4	3.1	0.1
Apricots	85.0	1.1	....	12.4	0.5	....	1.0
Peaches	88.8	0.5	0.2	5.8	0.6	3.4	0.7
Green gages	80.8	0.4	....	13.4	0.3	4.1	1.0
Plums	78.4	1.0	....	14.8	0.5	4.3	1.0
Nectarines	82.9	0.6	....	15.9	0.6	....	.....
Cherries	84.0	0.8	0.8	10.0	0.6	3.8	1.0
Gooseberries	86.0	0.4	....	8.9	0.5	2.7	1.5
Currants	85.2	0.4	....	7.9	0.5	4.6	1.4
Strawberries	89.1	1.0	0.5	6.3	0.7	2.2	1.0
Whortleberries	76.3	0.7	3.0	5.8	0.4	12.2	1.6
Blackberries	88.9	0.9	2.1	2.3	0.6	5.2	.....
Raspberries	84.4	1.0	....	5.2	0.6	7.4	1.4
Cranberries	86.5	0.5	0.7	3.9	0.2	6.2	2.2
Mulberries	84.7	0.3	....	11.4	0.6	0.9	1.8
Grapes	79.0	1.0	1.0	15.5	0.5	2.5	0.5
Melons	89.8	0.7	0.3	7.6	0.6	1.0	.....
Watermelon	92.9	0.3	0.1	6.5	0.2	....	.....
Bananas	74.0	1.5	0.7	22.9	0.9	0.2	.....
Oranges	86.7	0.9	0.6	8.7	0.6	1.5	1.8
Lemons	89.3	1.0	0.9	8.3	0.5	....	.....
Lemon juice	90.0	....	....	2.0	0.4	....	7.0
Pineapples	89.3	0.4	0.3	9.7	0.3	....	.....
Dates, dried	20.8	4.4	2.1	65.7	1.5	5.5	.....
Figs, dried	20.0	5.5	0.9	62.8	2.3	7.3	1.2
Figs, fresh	79.1	1.5	....	18.8	0.6	....	.....
Prunes, dried	26.4	2.4	0.8	66.2	1.5	....	2.7
Prunes, fresh	80.2	0.8	....	18.5	0.5	....	.....
Currants, dry	27.9	1.2	3.0	64.0	2.2	1.7	.....
Raisins	14.0	2.5	4.7	74.7	4.1	....	.....

COMPOSITION OF NUTS AND SOME OTHER FOOD MATERIALS

Nuts, etc.	Refuse	Edible portion	Composition and fuel value of the edible portions					
			Water	Protein	Fat	Carbohydrates	Ash	Fuel value, per pound
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Almonds	64.8	35.2	4.8	21.0	54.9	17.3	2.0	[1]3030
Brazil nuts	49.6	50.4	5.3	17.0	66.8	7.0	3.9	3329
Filberts	52.1	47.9	3.7	15.6	65.3	13.0	2.4	3432
Hickory nuts	62.2	37.8	3.7	15.4	67.4	11.4	2.1	3495
Pecans	53.2	46.8	3.0	11.0	71.2	13.3	1.5	3633
English walnuts	58.0	42.0	2.8	16.7	64.4	14.8	1.3	[1]3305
Chestnuts, fresh	16.0	84.0	45.0	6.2	5.4	42.1	1.3	[1]1125
Chestnuts, dried	24.0	76.0	5.9	10.7	7.0	74.2	2.2	[1]1875
Acorns	35.6	64.4	4.1	8.1	37.4	48.0	2.4	2718
Beechnuts	40.8	59.2	4.0	21.9	57.4	13.2	3.5	3263
Butternuts	86.4	13.6	4.5	27.9	61.2	3.4	3.0	3371
Walnuts	74.1	25.9	2.5	27.6	56.3	11.7	1.9	[1]3105
Coconut	48.8	51.2	14.1	5.7	50.6	27.9	1.7	2986
Coconut, shredded		100.0	3.5	6.3	57.3	31.6	1.3	[1]3125
Pistachio, kernels		100.0	4.2	22.6	54.5	15.6	3.1	[1]3010
Pine nut or piñon (*Pinus edulis*)	40.6	59.4	3.4	14.6	61.9	17.3	2.8	3364
Peanuts, raw	24.5	75.5	9.2	25.8	38.6	24.4	2.0	[1]2560
Peanuts, roasted	32.6	67.4	1.6	30.5	49.2	16.2	2.5	3177
Litchi nuts	41.6	58.4	17.9	2.9	0.2	77.5	1.5	1453
Beefsteak	12.8	87.2	61.9	18.9	18.5	......	1.0	[1]1130
Wheat flour		100.0	12.8	10.8	1.1	74.8	0.5	[1]1640
Potatoes	20.0	80.0	78.3	2.2	0.1	18.4	1.0	[1]385

[1] These values were calculated; unless otherwise indicated the fuel values were determined.

TABLE SHOWING THE CHEMICAL COMPOSITION AND FUEL VALUE PER POUND OF MEATS

Kind and cut of meat	Refuse	Water	Water-free substance	Nutrients: Protein	Nutrients: Fat	Nutrients: Carbohydrates	Nutrients: Ash	Fuel value per pound
BEEF			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Brisket:	Per cent.	Per cent.						Calories
Edible portion		47.4	52.6	14.6	37.2	......	0.8	1840
As purchased	14.3	40.6	45.1	12.5	31.9	......	0.7	1580
Chuck, with shoulder								
Edible portion		67.8	32.2	19.0	12.3	......	0.9	870
As purchased	17.0	56.3	26.7	15.7	10.2	......	0.8	720
Chuck ribs:								
Edible portion		57.3	42.7	17.4	24.4	......	0.9	1355
As purchased	13.8	49.3	36.9	15.0	21.1	......	0.8	1170
Flank:								
Edible portion		59.3	40.7	17.6	22.2	......	0.9	1260
As purchased	6.6	55.5	37.9	16.5	20.6	......	0.8	1175
Loin:								
Edible portion		60.5	39.5	18.3	20.2	......	1.0	1190
As purchased	13.0	52.6	34.4	15.9	17.6	......	0.9	1040
Neck:								
Edible portion		63.4	36.6	19.2	16.5	......	0.9	1055
As purchased	27.6	45.9	26.5	13.9	11.9	......	0.7	760
Plate:								
Edible portion		52.7	47.3	15.4	31.1	......	0.8	1600
As purchased	14.7	44.9	40.4	13.1	26.6	......	0.7	1365
Ribs:								
Edible portion		55.4	44.6	16.9	26.8	......	0.9	1445
As purchased	20.8	43.8	35.4	13.4	21.3	......	0.7	1150
Ribs, cross:								
Edible portion		43.9	56.1	13.7	41.6	......	0.8	2010
As purchased	12.2	38.6	49.2	12.0	36.5	......	0.7	1765
Round:								
Edible portion		65.8	34.2	19.7	13.5	......	1.0	935
As purchased	7.7	60.7	31.6	18.1	12.6	......	0.9	870
Round, second cut:								
Edible portion		69.5	30.5	20.6	8.6	......	1.3	745
As purchased	32.1	47.2	20.7	14.0	5.8	......	0.9	505
Rump:								
Edible portion		56.7	43.3	16.8	25.6	......	0.9	1395
As purchased	21.4	44.5	34.1	13.2	20.2	......	0.7	1095
Shank, fore:								
Edible portion		67.9	32.1	19.6	11.6	......	0.9	855
As purchased	36.9	42.9	20.2	12.3	7.3	......	0.6	535
Shank, hind:								
Edible portion		67.8	32.2	19.8	11.5	......	0.9	855
As purchased	53.9	31.3	14.8	9.1	5.3	......	0.4	395
Shoulder and clod:[1]								
Edible portion		68.3	31.7	19.3	11.3	......	1.1	835
As purchased	16.4	56.8	26.8	16.1	9.8	......	0.9	715

[1] The clod itself has no bone—*i.e.*, refuse.

TABLE SHOWING THE CHEMICAL COMPOSITION AND FUEL VALUE PER POUND OF MEATS—(*Continued*)

Kind and cut of meat	Refuse	Water	Nutrients: Water-free substance	Protein	Fat	Carbohydrates	Ash	Fuel value per pound
BEEF			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Fore quarter:	Per cent.	Per cent.						Calories
Edible portion		61.4	38.6	17.5	20.2	......	0.9	1180
As purchased	19.4	49.5	31.1	14.1	16.3	......	0.7	950
Hind quarter:								
Edible portion		61.0	39.0	18.0	20.1	......	0.9	1185
As purchased	15.8	51.3	32.9	15.2	17.0	......	0.7	1000
Side:								
Edible portion		60.6	39.4	17.7	20.8	......	0.9	1205
As purchased	18.3	49.7	32.0	14.5	16.8	......	0.7	980
Liver, as purchased		69.8	30.2	21.6	5.4	1.8	1.4	665
Cooked, corned, and canned, as purchased		53.1	46.9	28.5	14.0	......	4.4	1120
Corned brisket:								
Edible portion		50.9	49.1	18.7	24.7	......	5.7	1390
As purchased	21.4	40.0	38.6	14.7	19.4	......	4.5	1090
Corned flank:								
Edible portion		49.9	50.1	14.2	33.0	......	2.9	1660
As purchased	12.1	43.7	44.2	12.4	29.2	......	2.6	1465
Corned plate:								
Edible portion		40.1	59.9	13.3	41.9	......	4.7	2015
As purchased	14.5	34.3	51.2	11.4	35.8	......	4.0	1720
Corned rump:								
Edible portion		58.1	41.9	15.3	23.3	......	3.3	1270
As purchased	6.0	54.5	39.5	14.4	22.0	......	3.1	1195
Dried and smoked, as purchased		50.8	49.2	31.8	6.8	0 6	10.0	845
Tongue:								
Canned, whole, as purchased		51.3	78.7	21.5	23.2	......	4.0	1380
Canned, ground, as purchased		49.9	50.1	21.0	25.1	......	4.0	1450
Pickled, as purchased		62.3	37.7	12.5	20.5	......	4.7	1100
VEAL								
Breast:								
Edible portion		66.4	33.6	18.8	13.8	......	1.0	930
As purchased	20.6	52.7	26.7	14.9	11.0	......	0.8	740
Chuck:								
Edible portion		73.3	26.7	19.2	6.5	......	1.0	630
As purchased	18.9	59.5	21.6	15.6	5.2	......	0.8	510
Flank, as purchased		68.9	31.1	19.7	10.4	......	1.0	805
Leg, whole:								
Edible portion		70.4	29.6	20.1	8.4	......	1.1	730
As purchased	15.6	59.4	25.0	16.9	7.2	......	0.9	620
Leg, cutlets:								
Edible portion		68.3	31.7	20.8	9.9	......	1.0	805
As purchased	4.0	65.6	30.4	20.0	9.5	......	0.9	775

TABLE SHOWING THE CHEMICAL COMPOSITION AND FUEL VALUE PER POUND OF MEATS—(*Continued*)

Kind and cut of meat	Refuse	Water	Nutrients: Water-free substance	Protein	Fat	Carbohydrates	Ash	Fuel value per pound
VEAL			Per	Per	Per	Per	Per	
Loin:	Per cent.	Per cent.	cent.	cent.	cent.	cent.	cent.	Calories
Edible portion	....	69.2	30.8	19.4	10.4	......	1.0	800
As purchased	17.3	57.2	25.5	16.0	8.6	......	0.9	660
Neck:								
Edible portion	....	72.6	27.4	19.5	6.9	......	1.0	655
As purchased	31.5	49.9	18.6	13.3	4.6	......	0.7	440
Rib:								
Edible portion	....	72.5	27.5	20.2	6.2	......	1.1	635
As purchased	26.9	53.0	20.1	14.7	4.6	......	0.8	470
Rump:								
Edible portion	....	62.6	37.4	20.1	16.2	......	1.1	1055
As purchased	30.2	43.7	26.1	14.0	11.3	......	0.8	735
Shank, fore:								
Edible portion	....	74.0	26.0	19.8	5.2	......	1.0	590
As purchased	40.4	44.1	15.5	11.8	3.1	......	0.6	350
Shank, hind:								
Edible portion	....	74.5	25.5	19.9	4.6	......	1.0	565
As purchased	62.7	27.8	9.5	7.4	1.7	......	0.4	210
Fore quarter:								
Edible portion	....	71.7	28.3	19.4	8.0	......	0.9	700
As purchased	24.5	54.2	21.3	14.6	6.0	......	0.7	525
Hind quarter:								
Edible portion	....	70.9	29.1	19.8	8.3	......	1.0	720
As purchased	20.7	56.2	23.1	15.7	6.6	......	0.8	570
Side:								
Edible portion	....	71.3	28.7	19.6	8.1	......	1.0	705
As purchased	22.6	55.2	22.2	15.1	6.3	......	0.8	545
Liver, as purchased	....	73.1	26.9	20.4	5.3	......	1.2	605
LAMB								
Breast:								
Edible portion	....	56.2	43.8	19.2	23.6	......	1.0	1355
As purchased	19.1	45.5	35.4	15.5	19.1	......	0.8	1095
Leg, hind:								
Edible portion	....	63.9	36.1	18.5	16.5	......	1.1	1040
As purchased	17.4	52.9	29.7	15.2	13.6	......	0.9	855
Loin:								
Edible portion	....	53.1	46.9	17.6	28.3	......	1.0	1520
As purchased	14.8	45.3	39.9	15.0	24.1	......	0.8	1295
Neck:								
Edible portion	....	56.7	43.3	17.5	24.8	......	1.0	1375
As purchased	17.7	46.7	35.6	14.4	20.4	......	0.8	1130
Shoulder:								
Edible portion	....	51.8	48.2	17.5	29.7	......	1.0	1580
As purchased	20.3	41.3	38.4	14.0	23.6	......	0.8	1255

TABLE SHOWING THE CHEMICAL COMPOSITION AND FUEL VALUE PER POUND OF MEATS—(*Continued*)

Kind and cut of meat	Refuse	Water	Water-free substance	Nutrients: Protein	Fat	Carbohydrates	Ash	Fuel value per pound
MUTTON	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Calories
Chuck:								
Edible portion	....	50.9	49.1	14.6	33.6	......	0.9	1690
As purchased	21.3	39.9	38.8	11.5	26.7	......	0.6	1340
Flank, as purchased	....	45.8	54.2	14.8	38.7	......	0.7	1910
Leg, hind:								
Edible portion	....	62.8	37.2	18.2	18.0	......	1.0	1100
As purchased	18.0	51.4	30.6	14.9	14.9	......	0.8	905
Loin:								
Edible portion	....	50.1	49.9	15.9	33.2	......	0.8	1695
As purchased	15.3	42.2	42.5	13.2	28.6	......	0.7	1450
Neck:								
Edible portion	....	58.2	41.8	16.3	24.5	.....	1.0	1335
As purchased	28.4	41.6	30.0	11.7	17.6	.....	0.7	960
Shoulder:								
Edible portion	....	61.9	38.1	17.3	19.9	......	0.9	1160
As purchased	21.7	48.5	29.8	13.5	15.6	......	0.7	910
Fore quarter:								
Edible portion	....	51.7	48.3	15.0	32.4	......	0.9	1645
As purchased	21.1	40.6	38.3	11.9	25.7	......	0.7	1305
Hind quarter:								
Edible portion	....	54.8	45.2	16.2	28.2	......	0.8	1490
As purchased	16.7	45.6	37.7	13.5	23.5	......	0.7	1245
Side, without tallow:								
Edible portion	....	53.1	46.9	15.4	30.7	......	0.7	1580
As purchased	19.2	42.9	37.9	12.5	24.7	......	0.7	1275
PORK								
Chuck and shoulder:								
Edible portion	....	51.1	48.9	16.9	31.1	......	0.9	1630
As purchased	18.1	41.8	40.1	13.8	25.5	......	0.8	1335
Flank:								
Edible portion	....	59.0	41.0	17.8	22.2	......	1.0	1265
As purchased[1]	71.2	17.0	11.8	5.1	6.4	......	0.3	365
Loin:								
Edible portion	....	52.0	48.0	16.8	30.3	......	0.9	1590
As purchased	15.8	43.8	40.4	14.1	25.6	......	0.7	1340
Leg, hind:								
Edible portion	....	62.8	37.2	18.5	17.7	......	1.0	1090
As purchased	42.4	35.7	21.9	10.7	10.6	......	0.6	645
Ham, smoked:								
Edible portion	....	40.7	59.3	15.5	39.1	......	4.7	1940
As purchased	14.4	34.9	50.7	13.3	33.4	......	4.0	1655
Ham, boneless, as purchased	....	50.1	49.9	15.4	28.5	......	6.0	1490
Shoulder, fresh:								
Edible portion	....	57.5	42.5	15.6	26.1	......	0.8	1390
As purchased	46.6	30.4	23.0	8.3	14.3	.....	0.4	760

[1] Refuse includes fat trimmings.

TABLE SHOWING THE CHEMICAL COMPOSITION AND FUEL VALUE PER POUND OF MEATS—(*Continued*)

Kind and cut of meat	Refuse	Water	Nutrients: Water-free substance	Protein	Fat	Carbohydrates	Ash	Fuel value per pound
PORK			Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Shoulder, smoked:	Per cent.	Per cent.						Calories
Edible portion		46.8	53.2	15.5	33.3	......	4.4	1695
As purchased	15.4	39.8	44.8	13.1	28.1	......	3.6	1430
Salt, clear fat, as purchased		7.3	92.7	1.8	87.2	......	3.7	3715
Salt, lean ends:								
Edible portion		19.9	80.1	7.3	67.1	......	5.7	2965
As purchased	11.2	17.6	71.2	6.5	59.6	......	5.1	2635
Bacon, smoked:								
Edible portion		18.2	81.8	10.0	67.2	......	4.6	3020
As purchased	8.0	16.8	75.2	9.2	61.8	......	4.2	2780
Feet:								
Edible portion		68.2	31.8	16.1	14.8	......	0.9	925
As purchased	35.5	44.6	19.9	10.0	9.3	......	0.6	580
Ham, deviled, canned, as purchased		45.3	54.7	18.9	32.9	......	2.9	1740
Side: Edible portion		29.4	70.6	8.5	61.7	......	0.4	2760
As purchased	11.2	26.1	62.7	7.5	54.8	......	0.4	2455
SAUSAGE								
Bologna: Edible portion		59.5	40.5	18.6	18.2	0.1	3.6	1115
As purchased[1]	3.3	55.2	41.5	18.0	19.7	......	3.8	1165
Frankfort, as purchased		55.5	44.5	21.7	18.8	0.4	3.6	1205
Pork, as purchased		38.7	61.3	12.8	45.4	0.8	2.3	2155
Tongue, as purchased		46.4	53.6	17.3	33.1	......	3.2	1720
SOUPS, CANNED								
Bouillon, as purchased		96.5	3.5	2.0	0.1	0.2	1.2	45
Chicken, as purchased		93.8	6.2	3.6	0.1	1.5	1.0	100
Consommé, as purchased		96.0	4.0	2.5	......	0.4	1.1	55
Mock turtle, as purchased		89.8	10.2	5.2	0.9	2.8	1.3	185
Ox tail, as purchased		88.8	11.2	4.0	1.3	4.3	1.6	210
Tomato, as purchased		90.0	10.0	1.8	1.1	5.6	1.5	185
POULTRY								
Chicken: Edible portion		74.2	25.8	22.8	1.8	......	1.2	500
As purchased	34.8	48.5	16.7	14.8	1.1	......	0.8	325
Fowl:								
Edible portion		66.3	33.7	18.2	14.4	......	2.1	945
As purchased	30.0	46.5	23.5	12.5	10.2	......	0.8	665
Goose:								
Edible portion		42.3	57.7	13.0	43.9	......	0.8	2095
As purchased	22.2	33.1	44.7	10.3	33.8	......	0.6	1620
Turkey:								
Edible portion		55.5	44.5	20.6	22.9	......	1.0	1350
As purchased	22.7	42.4	34.9	15.7	18.4	......	0.8	1070
Chicken, canned, as purchased		46.9	53.1	20.5	30.0	......	2.6	1645
Quail, canned, as purchased		66.9	33.1	21.8	8.0	1.7	1.6	775
Turkey, canned, as purchased		47.4	52.6	20.7	29.2	......	2.7	1400

[1] Refuse, case.

COMPOSITION OF FISH, MOLLUSKS, CRUSTACEANS, ETC.

Kind of food material	Refuse (bone, skin, etc.)	Salt	Water	Protein	Fats	Carbohydrates	Mineral matter	Total nutrients	Fuel value per pound
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Calories
FRESH FISH									
Alewife, whole	49.5	.....	37.5	9.7	2.5	.....	0.8	13.0	285
Bass, large-mouthed black, dressed	46.7	.....	41.9	10.3	0.5	.....	0.6	11.4	215
Bass, large-mouthed black, whole	56.0	.....	34.6	8.5	0.4	.....	0.5	9.4	175
Bass, small-mouthed black, dressed	46.4	.....	40.1	11.5	1.3	.....	0.7	13.5	270
Bass, small-mouthed black, whole	53.6	.....	34.7	10.0	1.1	.....	0.6	11.7	230
Bass, sea, dressed	46.8	.....	42.2	10.1	0.2	.....	0.7	11.0	195
Bass, sea, whole	56.1	.....	34.8	8.3	0.2	.....	0.6	9.1	160
Bass, striped, dressed	51.2	.....	37.4	8.7	2.2	.....	0.5	11.4	255
Blackfish, dressed	55.7	.....	35.0	8.3	0.5	.....	0.5	9.3	175
Bluefish, dressed	48.6	.....	40.3	9.8	0.6	.....	0.7	11.1	205
Butterfish, dressed	34.6	.....	45.8	11.7	7.2	.....	0.7	19.6	520
Butterfish, whole	42.8	.....	40.1	10.2	6.3	.....	0.6	17.1	455
Carp (European analysis)	37.1	.....	48.4	12.9	0.7	.....	0.9	14.5	270
Cod, dressed	29.9	.....	58.5	10.6	0.2	.....	0.8	11.6	205
Cod, steaks	9.2	.....	72.4	16.9	0.5	.....	1.0	18.4	335
Cusk, dressed	40.3	.....	49.0	10.1	0.1	.....	0.5	10.7	190
Eel, salt-water, dressed	20.2	.....	57.2	14.6	7.2	.....	0.8	22.6	575
Flounder, common, dressed	57.0	.....	35.8	6.3	0.3	.....	0.6	7.2	130
Flounder, winter, dressed	56.2	.....	37.0	6.1	0.2	.....	0.5	6.8	120
Hake, dressed	52.5	.....	39.5	7.2	0.3	.....	0.5	8.0	145
Haddock, dressed	51.0	.....	40.0	8.2	0.2	.....	0.6	9.0	160
Halibut, dressed	17.7	.....	61.9	15.1	4.4	.....	0.9	20.4	465
Herring, whole	46.0	.....	37.3	10.0	5.9	.....	0.8	16.7	435
Mackerel, dressed	40.7	.....	43.7	11.4	3.5	.....	0.7	15.6	360
Mackerel, Spanish, dressed	24.4	.....	51.4	15.8	7.2	.....	1.2	24.2	595
Mackerel, Spanish, whole	34.6	.....	44.5	13.7	6.2	.....	1.0	20.9	515
Mullet, dressed	49.0	.....	38.2	9.8	2.4	.....	0.6	12.8	285
Mullet, whole	57.9	.....	31.5	8.1	2.0	.....	0.5	10.6	235
Perch, white, dressed	54.6	.....	34.4	8.7	1.8	.....	0.5	11.0	235
Perch, white, whole	62.5	.....	28.4	7.2	1.5	.....	0.4	9.1	195
Perch, yellow, dressed	35.1	.....	50.7	12.6	0.7	.....	0.9	14.2	265
Pickerel, dressed	35.9	.....	51.1	11.9	0.2	.....	0.9	13.0	230
Pickerel, whole	47.1	.....	42.2	9.8	0.2	.....	0.7	10.7	190
Pike, dressed	30.5	.....	55.4	13.0	0.4	.....	0.7	14.1	260
Pike, whole	42.7	.....	45.7	10.7	0.3	.....	0.6	11.6	210
Pollock, dressed	28.5	.....	54.3	15.5	0.6	.....	1.1	17.2	315
Pompano, dressed	45.5	.....	39.5	10.2	4.3	.....	0.5	15.0	370
Porgy, dressed	53.7	.....	34.6	8.6	2.4	.....	0.7	11.7	260
Porgy, whole	60.0	.....	29.9	7.4	2.1	.....	0.6	10.1	225
Red grouper, dressed	55.9	.....	35.0	8.4	0.2	.....	0.5	9.1	165
Red snapper, dressed	48.9	.....	40.3	9.6	0.6	.....	0.6	10.8	205
Salmon, California (sections)	5.2	.....	60.3	16.5	17.0	.....	1.0	34.5	1025
Salmon, Maine, dressed	23.8	.....	51.2	14.6	9.5	.....	0.9	25.0	675
Shad, dressed	43.9	.....	39.6	10.3	5.4	.....	0.8	16.5	420
Shad, whole	50.1	.....	35.2	9.2	4.8	.....	0.7	14.7	375
Shad, roe	.....	.....	71.2	23.4	3.8	.....	1.6	28.8	595
Smelt, whole	41.9	.....	46.1	10.0	1.0	.....	1.0	12.0	230
Sturgeon, dressed	14.4	.....	67.4	15.4	1.6	.....	1.2	18.2	355
Tomcod, dressed	51.4	.....	39.6	8.2	0.3	.....	0.5	9.0	165
Tomcod, whole	59.9	.....	32.7	6.8	0.2	.....	0.4	7.4	135
Trout, brook, dressed	37.9	.....	48.4	11.7	1.3	.....	0.7	13.7	275
Trout, brook, whole	48.1	.....	40.4	9.8	1.1	.....	0.6	11.5	230
Trout, lake, dressed	35.2	.....	45.0	12.4	6.6	.....	0.8	19.8	510
Turbot, dressed	39.5	.....	43.1	7.9	8.7	.....	0.8	17.4	515
Turbot, whole	47.7	.....	37.3	6.8	7.5	.....	0.7	15.0	440
Weakfish, dressed	41.7	.....	46.1	10.2	1.3	.....	0.7	12.2	245
Weakfish, whole	51.9	.....	38.0	8.4	1.1	.....	0.6	10.1	200
Whitefish, dressed	43.6	.....	39.4	12.5	3.6	.....	0.9	17.0	385
Whitefish, whole	53.5	.....	32.5	10.3	3.0	.....	0.7	14.0	320
General average of fresh fish as sold	42.0	.....	44.0	10.5	2.5	.....	1.0	14.0	300

COMPOSITION OF FISH, MOLLUSKS, CRUSTACEANS, ETC.—(*Continued*)

Kind of food material	Refuse (bone skin, etc.)	Salt	Water	Protein	Fats	Carbohydrates	Mineral matter	Total nutrients	Fuel value per pound
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Calories
PRESERVED FISH									
Mackerel, "No. 1," salted	33.3	7.1	28.1	14.7	15.1	.....	1.7	31.5	910
Cod, salted and dried	24.9	17.2	40.3	16.0	0.4	.....	1.2	17.6	315
Cod, "boneless codfish," salted and dried	......	21.5	54.4	22.1	0.3	.....	1.7	24.1	425
Caviare	......	.....	38.1	30.0	19.7	7.6	[1]4.6	61.9	1530
Herring, salted, smoked, and dried	44.4	6.5	19.2	20.2	8.8	.....	0.9	29.9	45
Haddock, "Finnan-haddock," salted, smoked, and dried	32.2	1.4	49.2	16.1	0.1	.....	1.0	17.2	305
Halibut, salted, smoked, and dried	6.9	12.1	46.0	19.1	14.0	.....	1.9	35.0	945
Sardines, canned	5.0	.....	53.6	24.0	12.1	.....	5.3	41.4	955
Salmon, canned	3.9	1.0	59.3	19.3	15.3	.....	1.2	35.8	1005
Mackerel, canned	......	1.9	68.2	19.9	8.7	.....	1.3	29.9	735
Mackerel, salt, canned	19.7	8.3	34.8	13.8	21.3	.....	2.1	37.2	1155
Tunny (horse mackerel), canned	......	.....	72.7	21.5	4.1	.....	1.7	27.3	575
Haddock, smoked, canned	......	5.6	68.7	21.8	2.3	.....	1.6	25.7	505
MOLLUSKS									
Oysters, solids	......	.....	88.3	6.1	1.4	3.3	0.9	11.7	235
Oysters, in shell	82.3	.....	15.4	1.1	0.2	0.6	0.4	2.3	40
Oysters, canned	......	.....	85.3	7.4	2.1	3.9	1.3	14.7	300
Scallops	......	.....	80.3	14.7	0.2	3.4	1.4	19.7	345
Long clams, in shell	43.6	.....	48.4	4.8	0.6	1.1	1.5	8.0	135
Long clams, canned	......	.....	84.5	9.0	1.3	2.9	2.3	15.5	275
Round clams, removed from shell	......	.....	80.8	10.6	1.1	5.2	2.3	19.2	340
Round clams, in shell	68.3	.....	27.3	2.1	0.1	1.3	0.9	4.4	65
Round clams, canned	......	.....	83.0	10.4	0.8	3.0	2.8	17.0	285
Mussels	49.3	.....	42.7	4.4	0.5	2.1	1.0	8.0	140
General average of mollusks (exclusive of canned)	60.2	.....	34.0	3.2	0.4	1.3	0.9	5.8	100
CRUSTACEANS									
Lobster, in shell	62.1	.....	31.1	5.5	0.7	.....	0.6	6.8	130
Lobster, canned	......	.....	77.8	18.1	1.1	0.6	2.4	22.2	395
Crawfish, in shell	87.7	.....	10.0	2.0	0.1	0.1	0.1	2.3	45
Crab, in shell	55.8	.....	34.1	7.3	0.9	0.5	1.4	10.1	185
Crab, canned	......	.....	80.0	15.8	1.5	0.8	1.9	20.0	370
Shrimp, canned	......	.....	70.8	25.4	1.0	0.2	2.6	29.2	520
General average of crustaceans (exclusive of canned)	73.7	.....	20.9	4.3	0.4	0.2	0.5	5.4	100
TERRAPIN, TURTLE, ETC.									
Terrapin, in shell	79.0	.....	15.6	4.5	0.7	.....	0.2	5.4	115
Green turtle, in shell	76.0	.....	19.1	4.5	0.1	.....	0.3	4.9	90
Average of turtle and terrapin	77.5	.....	17.4	4.2	0.7	.....	0.2	5.1	105
Frogs' legs	32.0	.....	57.0	10.2	0.1	.....	0.7	11.0	210
General average of fish, mollusks crustaceans, etc.	44.0	.....	42.5	10.0	2.5	0.1	0.9	13.5	295

[1] Including salt.

TABLE II.—COMMON FOOD VALUES

This table, compiled by Dr. E. A. Locke (see "Food Values") will be found convenient for the purpose of estimating the food value of an ordinary meal from the "portions" usually served.

To determine percentage composition from this table, in any case where this is desired, determine the amount of 100 grams, when that is not the amount given, and the figures obtained will represent percentage composition. In a similar way the total calories in 100 grams can be obtained.

COMMON FOOD VALUES

Foodstuffs	Quantity	Weight, grams	Protein, grams	Fats, grams	Carbohydrates	Total calories
Beef juice	4 ounces	120	5.88	0.72	....	31
Corned beef hash	2 heaping tablespoons	100	6.00	1.90	9.40	81
Roast beef	1 slice	100	22.30	28.60	....	357
Steak, tenderloin beef	1 slice	100	23.50	20.40	....	286
Sweetbreads, 2	....	80	32.00	0.45	....	135
Creamed chicken on toast	2 heaping tablespoons	125	16.26	12.62	21.76	273
Roast chicken	1 slice	100	32.10	4.40	2.10	181
Lamb chop with bone	1 chop	100	21.70	29.90	....	367
Roast lamb	1 slice	75	14.78	9.53	....	150
Boiled mutton, lean	1 slice	75	23.18	3.38	....	126
Mutton chop, lean	1 chop	100	22.60	4.50	....	135
Mutton, roast leg	1 slice	75	18.75	16.95	....	234
Ham, smoked, boiled, as purchased	1 slice	33	7.29	6.80	....	93
Ham, smoked, fried	1 slice	35	7.77	11.62	....	140
Roast turkey	1 slice	100	27.80	18.40	....	285
Veal cutlet	1 cutlet	80	22.82	1.14	....	104
Veal roast	1 slice	75	21.33	1.00	....	97
Bluefish	Average helping	100	25.90	4.50	....	148
Codfish	Average helping	100	21.68	0.27	1.58	98
Halibut	Average helping	100	20.35	4.04	....	121
Mackerel	Average helping	70	11.73	4.84	2.62	104
Salmon	Average helping	100	19.65	10.21	5.36	198
Sardines, canned	1 fish	10	2.30	1.97	....	28
Clams, round	6 clams	100	6.50	0.4	4.20	47
Crabs, hard shelled, as purchased	1 crab	245	19.36	2.21	1.47	106
Oysters	6 oysters	85	5.27	1.02	3.15	44
Oyster stew	4 ounces	124	6.07	11.06	10.53	171
Scalloped oysters	6 large oysters	138	8.06	18.58	11.98	255
Scallops, fried	3 heaping tablespoons	110	28.20	1.75	6.02	158
Bean soup, home-made	Teacup	120	3.84	1.68	11.28	78

COMMON FOOD VALUES—(*Continued*)

Foodstuffs	Quantity	Weight, grams	Protein, grams	Fats, grams	Carbohydrates	Total calories
Chicken soup, home-made	Teacup	120	12.60	0.96	2.88	72
Chicken gumbo soup, canned	Teacup	120	4.56	1.08	5.64	52
Consommé, canned	Teacup	120	3.00	....	0.48	14
Asparagus cream soup	Teacup	125	3.44	8.62	4.87	114
Celery cream soup	Teacup	125	3.00	8.94	5.01	116
Corn cream soup	Teacup	125	3.75	8.70	10.66	140
Pea cream soup	Teacup	125	6.29	8.46	14.07	162
Tomato cream soup	Teacup	125	2.99	9.40	6.36	126
Oxtail soup, canned	Teacup	120	4.80	1.56	5.16	55
Vegetable soup, canned	Teacup	120	3.48	....	0.6	17
Butter	1 ball	15	0.15	12.75	....	119
Average cream	1 tablespoon	20	0.74	5.14	0.71	54
American cheese, pale	1 cubic inch	20	5.70	7.18	0.06	91
Fromage de Brie	1 cubic inch	20	3.18	4.20	0.28	53
Full cream cheese	1 cubic inch	20	5.18	6.74	0.48	86
Roquefort cheese	1 cubic inch	20	4.52	5.90	0.36	75
Swiss cheese	1 slice	20	5.52	6.98	0.26	89
Buttermilk	1 glass	218	6.54	1.09	10.46	80
Whole milk	1 glass	220	7.26	8.80	11.00	157
Whey	1 glass	203	2.03	0.61	10.15	56
Hen's eggs, boiled	1 egg	50	6.60	6.00	....	83
Omelette, egg	1/2 omelette	75	9.80	14.01	1.55	177
Ingredients: 3 tablespoons milk, 3 eggs, 1 heaping teaspoon butter.						
Asparagus, canned	....	125	1.88	0.13	3.50	23
Baked beans, home-made	3 heaping tablespoons	150	10.83	12.76	32.84	298
Butter beans	4 heaping tablespoons	180	63.78	0.24	11.60	65
Lima beans	2 heaping tablespoons	80	6.40	0.54	23.60	128
String beans	2 heaping tablespoons	60	0.48	0.66	1.14	13
Beets	2 heaping tablespoons	70	1.61	0.07	5.18	29
Cabbage	3 heaping tablespoons	100	0.60	0.10	0.40	5
Carrots	3 heaping tablespoons	100	0.53	0.17	3.39	18
Cauliflower	2 heaping tablespoons	120	1.08	0.12	0.48	8
Celery, uncooked	3 small stalks	55	0.50	0.05	1.43	8
Corn, canned	2 heaping tablespoons	100	2.80	1.20	19.00	101
Corn, green	1 ear	100	3.07	1.10	18.78	100
Cucumber, uncooked	8 thin slices	50	0.40	0.10	1.55	9
Mushrooms, broiled	2 large on toast	57	3.52	8.94	12.85	150
Onions	1 onion	100	1.20	1.80	4.90	42
Peas, green	3 heaping tablespoons	92	6.16	3.13	13.43	110
Potatoes, sweet, boiled	Average size	100	3.00	2.10	42.1	204
Baked potatoes	Medium size	130	3.77	0.20	32.07	149
Boiled potatoes	Medium size	150	3.75	0.15	31.35	145
Mashed and creamed potatoes	2 heaping tablespoons	100	2.60	3.00	17.80	112
Squash	2 heaping tablespoons	100	1.36	0.82	13.60	69
Spinach	2 heaping tablespoons	100	2.10	4.10	2.60	57
Tomatoes, canned	2 heaping tablespoons	70	0.84	0.14	2.80	16
Tomatoes, uncooked	Medium size	200	2.40	0.40	8.00	46

COMMON FOOD VALUES—(*Continued*)

Foodstuffs	Quantity	Weight, grams	Protein, grams	Fats, grams	Carbohydrates	Total calories
Turnips	2 heaping tablespoons	140	0.45	0.08	0.91	6
Apple	Average size	150	0.45	0.45	16.22	72
Banana	Average size	194	1.55	0.78	27.74	127
Blackberries	3 heaping tablespoons	100	1.30	1.00	10.90	59
Cantaloupe	1/2 melon	465	1.40	....	21.39	93
Cherries	About 1/2 pound	100	0.90	0.80	15.90	76
Currants	4 heaping tablespoons	100	1.50	....	12.80	59
Grapefruit	1/2 large	300	2.37	0.60	30.27	139
Grapes	1 bunch	150	1.50	1.80	21.60	112
Gooseberries	4 heaping tablespoons	90	0.90	......	11.79	52
Huckleberries	4 heaping tablespoons	100	0.60	0.60	16.60	76
Orange	Average size	250	1.50	0.25	21.25	96
Peach	Average size	128	0.64	0.13	9.86	44
Pear	Average size	156	0.78	0.62	19.81	90
Pineapple, edible portion	2 slices	100	0.40	0.30	9.70	44
Plum	Average size	35	0.32	....	6.69	29
Raspberries	3 heaping tablespoons	82	0.82	....	10.33	46
Strawberries	4 heaping tablespoons	100	1.00	0.60	7.40	40
Watermelon	Large slice	300	0.60	0.30	8.10	39
Apricots, dried	10 large	80	3.76	0.80	50.00	228
Dates	10 large	83	1.58	2.08	58.60	266
Figs	10 large	117	8.38	0.58	592.8	633
Prunes	10 very large	200	3.60	....	124.40	525
Raisins	10 very large	25	0.57	0.75	17.13	80
Apple, baked	1 large	120	0.61	0.58	29.30	128
Apple, sauce	3 heaping tablespoons	125	0.25	1.00	46.50	201
Cranberries, stewed	2 heaping tablespoons	100	0.27	0.41	36.00	153
Currant jelly	1 heaping tablespoon	35	0.36	....	27.16	113
Marmalade, orange	1 heaping tablespoon	30	0.18	0.03	25.35	105
Rhubarb, stewed	2 heaping tablespoons	90	0.40	0.47	32.40	139
Graham bread	1 slice	37	3.29	0.67	19.28	99
Biscuits, home-made	1 biscuit	35	3.05	0.91	19.36	101
Biscuits, soda	1 biscuit	38	3.53	5.21	19.99	145
Rolls, French	1 roll	39	3.32	0.98	21.72	112
Whole wheat	1 slice	42	4.07	0.38	20.87	106
Zwieback	1 slice	15	1.47	1.49	11.03	65
Boston cracker (split)	1 cracker	10	1.10	0.85	7.11	42
Graham cracker	1 cracker	8	0.80	0.75	5.9	34
Oyster cracker	10 crackers	11	1.24	1.16	7.76	48
Pretzels	1 pretzel	6	0.58	0.23	4.37	22
Educators, soda cracker	1 cracker	3	0.97	....	1.39	10
Uneeda biscuits	1 cracker	6	0.59	0.55	4.38	25
Chicken sandwiches	1 sandwich	70	8.61	3.78	22.47	163
Egg sandwich	1 sandwich	100	9.60	12.70	34.50	299
Ham sandwich	1 sandwich	70	7.28	10.07	26.65	233
Cream toast	2 slices	136	9.03	14.60	37.15	325
Ingredients:						
2 slices toast						
5 tablespoons cream sauce.						

COMMON FOOD VALUES—(*Continued*)

Foodstuffs	Quantity	Weight, grams	Protein, grams	Fats, grams	Carbohydrates	Total calories
Grapenuts	5 heaping tablespoons	65	7.78	0.40	51.51	247
Cornmeal mush	4 heaping tablespoons	115	3.85	4.11	9.52	93
Ingredients: 2 tablespoons white cornmeal, 2 cups milk.						
Hominy, boiled	2 heaping tablespoons	100	2.20	0.20	17.80	84
Indian meal mush	3 heaping tablespoons	115	2.10	1.18	18.50	96
Macaroni, boiled	2 heaping tablespoons	100	3.00	1.50	15.80	91
Macaroni, baked with cheese	2 heaping tablespoons	140	19.06	20.46	43.44	447
Oatmeal, boiled	2 heaping tablespoons	100	2.80	0.50	11.50	63
Puffed rice	5 heaping tablespoons	14	0.87	0.08	12.00	54
Rice, boiled	1 heaping tablespoon	100	2.80	0.10	24.40	112
Shredded wheat biscuit	1 biscuit	29	3.05	0.41	22.59	109
Spaghetti, baked with tomato	3 heaping tablespoons	145	4.52	2.81	25.76	150
Apple pie	1/6 pie	126	3.91	12.35	53.93	352
Custard pie	1/6 pie	133	5.59	8.38	34.71	243
Lemon pie	1/6 pie	110	3.96	11.11	41.14	288
Mince pie	1/6 pie	113	6.55	13.90	43.05	333
Squash pie	1/6 pie	133	5.85	11.17	28.86	246
Bread pudding	2 heaping tablespoons	105	5.52	4.79	38.48	225
Ingredients: 1 cup bread crumbs, 1 cup milk, 1 egg, 1/2 cup sugar 1/4 cup raisins.						
Baked custard	2 heaping tablespoons	134	7.31	7.42	20.50	183
Ingredients: 2 cups milk, 2 eggs, 1/4 cup sugar.						
Soft custard	4 tablespoons	60	4.39	6.84	12.12	131
Ingredients: Yolk 1 egg, 1/2 cup milk, 1 heaping tablespoon sugar.						
Snow pudding	2 heaping tablespoons	80	4.52	0.03	11.73	67
Ingredients: 3/4 cup water, 1 heaping teaspoon gelatin, 2 heaping tablespoons sugar, 1 teaspoon lemon juice, lemon rind, white 1 egg.						
Tapioca pudding	3 heaping tablespoons	110	5.85	6.12	22.25	172
Ingredients: 2 cups milk, 1 egg, 3 tablespoons tapioca, 2 tablespoons sugar.						
Tapioca and apples	2 heaping tablespoons	100	0.21	0.22	28.58	120
Ingredients: 9 small apples, 1 cup sugar, 2/3 cup tapioca, 2 cups water.						

COMMON FOOD VALUES—(*Continued*)

Foodstuffs	Quantity	Weight, grams	Protein, grams	Fats, grams	Carbohydrates	Total calories
Blanc mange	2 heaping tablespoons	90	4.76	4.91	16.83	134
Ingredients: 1 heaping tablespoon corn starch, 1 heaping tablespoon sugar, 1 egg, 1 cup milk, 1 tablespoon sherry.						
Doughnuts	1 doughnut	37	2.48	7.77	19.65	163
Egg soufflé	1/2 soufflé	50	5.22	4.09	38.09	216
Ingredients: 2 eggs, 1/2 cup sugar, 1 tablespoon lemon juice.						
Ice cream	2 heaping tablespoons	100	5.21	10.16	17.73	189
Ingredients: 3 cups milk, 1 cup cream, 3 eggs, 2/3 cup sugar, vanilla.						
Ladyfingers	1	20	1.76	1.00	14.12	74
Macaroons	1	10	0.65	1.52	6.52	44
Orange ice	2 heaping tablespoons	100	0.94	0.23	74.68	312
Ingredients: 2 1/2 cups orange juice, 1/4 cup lemon juice, 1 1/2 cups sugar, 1 cup water, rind 2 oranges.						
Prune soufflé	2 heaping tablespoons	85	3.31	0.65	18.95	97
Ingredients: 1/2 cup stewed prunes (edible portion), white 1 egg.						
French dressing	1 dessertspoon	11	....	8.00	....	74
Ingredients: 4 tablespoons olive oil, 1 tablespoon vinegar, 1/4 teaspoon salt, pepper.						
Mayonnaise dressing	1 tablespoon	21	0.26	19.92	0.05	187
Ingredients: 2 eggs, 2 cups olive oil, 1 tablespoon vinegar or 1 tablespoon lemon juice, salt, pepper, mustard.						
Cube sugar	1 cube	7	....	....	7.00	29
Domino sugar	1 domino	6	....	....	6.00	25
Granulated sugar	1 heaping teaspoon	10	....	....	10.00	41
Powdered sugar	1 heaping teaspoon	12	....	....	12.00	49
Maple sugar	1 cake	100	....	....	82.80	339
Almonds	10 large	15	3.15	8.23	2.60	100
Brazil nuts	10 large	60	10.20	40.08	4.20	432
Chestnuts, roasted as purchased	20 nuts	50	2.60	2.25	17.70	104
Coconut	1 slice	34	1.94	17.20	9.49	207
Filberts	10 nuts	10	1.56	6.53	1.30	72
Peanuts, as purchased	15 nuts	30	5.85	8.73	5.55	128

COMMON FOOD VALUES—(*Continued*)

Foodstuffs	Quantity	Weight, grams	Protein, grams	Fats, grams	Carbohydrates	Total calories
Pecans	10 large	30	3.30	21.36	3.99	229
Walnuts	10 large	42	7.73	27.05	5.46	306
Cocoa	1 cup	227	9.08	15.53	23.85	279
Ingredients: 1 heaping teaspoon cocoa, 1 heaping teaspoon sugar, 3/4 cup milk, 1 tablespoon cream.						
Coffee or tea	1 cup	246	2.80	7.64	17.83	156
Ingredients: 1/4 cup milk, 1 tablespoon cream, 2 cubes sugar, coffee or tea.						
Eggnog	1 glass	270	13.00	12.85	29.50	294
Ingredients: 1 egg, 1 heaping tablespoon sugar, 3/4 cup milk, 1 tablespoon sherry.						

TABLE III.—CLASSIFICATION OF FOODS ACCORDING TO TOTAL NUTRIENTS

The following classification of foods by Elizabeth C. Sprague[1] will be found convenient for those who wish to understand which foods are nitrogenous, which principally starch, which represent fats, etc.

Kind of food as purchased	Total nutrients	Principal nutrient: Kind	Principal nutrient: Am't
1. Total nutrients less than 10 per cent.	Per cent.		Per cent.
A.—Principal nutrient carbohydrates			
Cucumbers	3.9	Carbohyd's	2.6
Celery	4.4	"	2.6
Lettuce	4.5	"	2.5
Tomatoes	5.7	"	3.9
Cabbage	7.3	"	4.8
Asparagus	6.0	"	3.3
Oatmeal gruel	8.4	"	6.3
Peaches	8.7	"	7.7
Buttermilk	9.0	"	4.8
Strawberries	9.1	"	7.0
Corn (green)	9.6	"	7.7
Oranges	9.6	"	8.5
Beets	10.0	"	7.7
B.—Principal nutrient protein			
Beef juice	7.0	Protein	4.9
Codfish (fresh)	8.8	"	8.4
Perch	9.1	"	7.3
2. Total nutrients 10 to 20 per cent.			
A.—Principal nutrient carbohydrates			
Apples	11.7	Carbohyd's	10.8
Milk	13.0	"	5.0
Peas (green)	14.2	"	9.8
Bananas	16.1	"	14.3
Cherries	18.2	"	15.9
Potatoes	17.4	"	14.7
B.—Principal nutrient protein	Per cent.		Per cent.
Veal shank (hind)	10.3	Protein	8.c
Oysters	11.7	"	6.0
Beef shank (hind)	13.6	"	9.7
Chicken (broilers)	14.7	"	12.8
Mackerel (fresh)	14.9	"	10.2
Lake trout	14.9	"	9.1
Veal shank (fore)	15.5	"	12.2
Beef shank (fore)	18.5	"	13.2
Veal neck	18.6	"	13.9
3. Total nutrients 20 to 30 per cent.			
A.—Principal nutrient carbohydrates			
Potatoes (sweet)	24.8	Carbohyd's	21.9
Peas (edible portion)	25.4	"	16.9
B.—Principal nutrient protein			
Beef tongue	21.7	Protein	14.1
Veal chuck	21.2	"	16.0
Veal rib	22.7	"	15.2
Eggs	23.3	"	11.9
Beef neck	23.5	"	14.2
Veal breast	24.2	"	15.3
Veal loin	24.8	"	16.1
Veal leg	24.9	"	18.3
Beef liver	27.1	"	20.2
Beef chuck rib	27.1	"	15.3
Chicken (fowls)	27.0	"	13.7
Chicken cheese	28.0	"	20.9
Beef, round	29.0	"	19.2
Canned salmon	29.0	"	19.5

[1] Bulletin No. 8, Illinois Farmers, Institute.

Kind of food as purchased	Total nutrients	Principal nutrient: Kind	Principal nutrient: Am't
4. Total nutrients 30 to 40 per cent.	Per-cent.		Per-cent.
A.—Principal nutrient protein			
Mutton leg	30.4	Protein	15.4
Pork tenderloin	33.5	"	18.9
Beef sirloin	33.2	"	16.5
Beef loin	33.8	"	16.4
Beef, porterhouse	34.9	"	16.2
Cod (salt)	34.9	"	19.0
Beef rib, roll	35.2	"	19.4
Beef flank	38.4	"	18.6
B.—Principal nutrient fat			
Mutton shoulder	31.1	Fat	17.1
Beef rump	34.1	"	18.6
Beef rib	34.6	"	20.0
Turkey	34.9	"	18.4
Beef plate	35.8	"	22.7
Lamb leg	35.9	"	19.7
Lamb shoulder	38.4	"	23.6
Lamb loin	39.9	"	24.1
Pork loin	39.9	"	26.0
5. Total nutrients 40 to 50 per cent.			
A.—Principal nutrient protein			
Sardines	41.6	Protein	23.7
Boneless salt cod	43.6	"	27.7
Dried beef	55.2	"	39.2
Corned beef (canned)	48.2	"	26.3
B.—Principal nutrient fat			
Pork leg	44.6	Fat	29.7
Mutton loin	44.8	"	31.5
Mackerel (salt)	45.5	"	21.2
6. Total nutrients 50 to 100 per cent.	Per-cent.		Per-cent.
A.—Principal nutrient carbohydrates			
White bread	64.7	Carbohyd's	53.1
Prunes (dried)	66.0	"	62.2
Apricots	70.6	"	62.5
Molasses	74.9	"	69.3
Dates	76.2	"	70.6
Honey	81.8	"	81.2
Beans (dried)	87.4	"	59.6
Corn meal	87.5	"	75.4
Rice	87.7	"	79.0
Wheat flour	88.0	"	75.1
Macaroni	89.7	"	74.1
Hominy	88.2	"	79.0
Tapioca	88.6	"	88.0
Lima beans (dried)	89.6	"	65.9
Oatmeal	92.7	"	67.5
Sugar (brown)	95.0	"	95.0
Sugar (granulated)	100.0	"	100.0
B.—Principal nutrient fat			
Almonds	52.3	Fat	30.2
Sausage	53.8	"	32.5
Peanuts	68.6	"	29.1
Cream cheese	65.8	"	33.7
Salt pork	71.2	"	59.6
Bacon	72.9	"	59.4
Butter	89.0	"	85.0
Cottolene	100.0	"	100.
Lard	100.0	"	100.

TABLE IV.—DIGESTIBILITY OF MEAT

The digestibility of Protein Foods has been already discussed (p. 347). The following table, compiled by N. S. Davis,[1] gives an idea of the time required to digest different kinds of meat in the stomach. The gastric digestion of proteins is not at present considered as important as formerly supposed, but it no doubt facilitates their more complete digestion in the intestine.

DIGESTIBILITY OF MEAT

	Penzoldt	Jessen	Richert	Beaumont
Boiled milk	1 to 2 hrs. 100 to 200 grams			
Bouillon	" " 200 "			
Eggs, raw	" " 100 "	...	2 to 3 hrs.	1 1/2 hrs.
Milk	" " ...	...	30 to 60 min.	2 "
Pigs' feet	" " ...	...	1 hr.	
Trout	" " ...	...	...	1 1/2 "
Calf's brains, boiled	" " ...	...	...	1 3/4 "
Boiled milk	2 to 3 hrs. 300 to 500 grams			
Eggs, hard boiled or omelet	" " 100 "			
Beef sausage, raw	" " 100 "			
Brains, boiled	" " 250 "			
Sweetbread	" " 250 "			
Oyster, raw	" " 72 "			
Carp, boiled	" " 200 "			
Pike, boiled	" " 200 "			
Sharper, boiled	" " 200 "			
Beef, raw, chopped fine	...	2 hrs.		
Beef, half cooked	...	2 1/2 hrs.		
Beef, well cooked	...	3 "		
Beef, thoroughly roasted	3 to 4 hrs. 100 grams	4 "		
Mutton, raw	...	2 "		
Veal, cooked	" " 100 "	2 1/2 "		
Pork, cooked	...	3 "		
Mutton, roasted	...	...	...	3 hrs.
Beefsteak	...	...	...	3 "
Ham, cooked	" " 160 "	...	...	3 "
Lean beef, broiled	...	...	...	3 "
Fish, boiled	...	...	...	3 "
Bacon, roasted	...	...	...	4 "
Poultry	...	...	...	4 "
Veal	...	...	...	4 "
Codfish, boiled	2 to 3 hrs. 200 grams			
Chicken, young, boiled	3 to 4 " 230 "			

[1] Food in Health and Disease, p. 99.

DIGESTIBILITY OF MEAT—(*Continued*)

	Penzoldt	Jessen	Richert	Beaumont
Partridge, roasted	3 to 4 hrs. 230 grams			
Pigeon, boiled	" " 250 "			
Beef, cooked	" " 250 "			
Calf's foot, boiled	" " 250 "			
Ham, raw	" " 160 "			
Beefsteak, raw, grated	" " 100 "			
Salmon, boiled	" " 100 "			
Caviar	" " 72 "			
Herring, pickled and smoked	" " 200 "			
Pigeon, roasted	4 to 5 hrs. 210 "			
Fillet of beef, roasted	" " 250 "			
Beef tongue, smoked	" " 250 "			
Bacon	" " 100 "			
Hare, roasted	" " 250 "			
Partridge, roasted	" " 240 "			
Goose, roasted	" " 250 "			
Duck, roasted	" " 280 "			

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